R E P O R T R E S U M E S

ED 015 870 SE 001 112

TEACHERS' GUIDES, AEROSPACE SCIENCE, GRADES K-6.

BY- TIMMONS, KAREN S.
LINCOLN PUBLIC SCHOOLS, NEBR.

PUB DATE 66

EDRS PRICE MF-$0.50 HC-$3.76 92P.

DESCRIPTORS- *ELEMENTARY SCHOOL SCIENCE, *SCIENCE ACTIVITIES, *TEACHING GUIDES, BIBLIOGRAPHIES, CONCEPT FORMATION, EARTH SCIENCE, PHYSICAL SCIENCES,

THIS IS A TEACHER GUIDE TO AEROSPACE SCIENCE TOPICS FOR USE IN GRADES KINDERGARTEN THROUGH SIX. UNITS OF STUDY ARE BASED ON MAN'S EFFORTS TO FLOAT, FLY, AND EXIST ABOVE THE EARTH'S SURFACE. FOR EACH TOPIC THERE ARE INCLUDED LISTS OF (1) CONCEPTS TO BE DEVELOPED, (2) SUGGESTED GROUP ACTIVITIES, (3) VOCABULARY, (4) TEACHER REFERENCE BOOKS, (5) STUDENT BOOKS, (6) FILMS, (7) FILMSTRIPS, (8) SINGLE CONCEPT FILMS, (9) OTHER AUDIOVISUAL AIDS, (10) SUGGESTED INDIVIDUAL ACTIVITIES, AND (11) QUESTIONS FOR USE IN EVALUATING STUDENTS. IN ADDITION, THERE IS A STATEMENT OF THE PROBLEM UNDER CONSIDERATION AND A BRIEF FACTUAL DEVELOPMENT OF THE CONTENT. (RS)

SE 001 112

ED015870

TEACHERS' GUIDES
AEROSPACE SCIENCE

GRADES K - 6

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

1112

September, 1966

The material in the attached aerospace science units for grades K-6 was developed as a part of the Lincoln, Nebraska Public Schools Aerospace Curriculum Development Project which is funded under Title III of the Elementary-Secondary Education Act.

The units were produced during an eight-week institute (13 June - 5 August 1966) sponsored cooperatively by the Lincoln Public Schools and the University of Nebraska. University Professor Frank E. Sorenson was general chairman of the institute; he was assisted by Richard Raecke, Kearney Public Schools, Bernard E. Nutt, Lincoln Public Schools, and Mrs. Jean Rademacher, Project Media Specialist. Dr. O. W. Kopp of the University is conducting an on-going evaluation of the Project.

The material in these units will be evaluated continuously throughout the 1966-1967 school year by Nebraska teachers. Provision has been made for a group of elementary school teachers to edit and up-date the material in light of these evaluations in the 1967 summer. It will be helpful to them if all teachers who use any one of the units will fill in the evaluation sheet and return it to the Project office.

It is our hope that you will find this aerospace science material helpful and interesting.

Steven N. Watkins
Superintendent of Schools, Lincoln, and
Administrator, Aerospace Curriculum
Development Project
Karen S. Timmons, Project Supervisor

K

K

TEACHER'S GUIDE

AEROSPACE SCIENCE

KINDERGARTEN

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school students on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts, which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Fred Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Laura Staats
Dolores Painter
Madelyn Palmer
Helen Robbins
Monica Shasteen
Theresa Stetz
James Winney

FROM EARTH-THROUGH AIR-INTO SPACE

A Kindergarten Aerospace Unit

OVERVIEW

Today's kindergarten children were born into a world with the dramatic new dimension of space exploration. Their entire lives have been lived in the years when what was possible only in the most imaginative science fiction has become a reality and a very real part of their environment.

It is hoped that this unit will be a starting point for the teacher to enlarge upon the natural interest and information that the five year old of today has in the world about him. It begins with the development of an awareness that the earth is the child's home and some basic understanding about the earth; the second problem concerns the importance and uses of the air which surrounds the earth; and the third problem deals with space as a part of our environment and what man is learning about it.

Changes have come about rapidly in the past few years and are certain to be more rapid in the future. This rapid change should be a constant guide to our teaching.

The kindergarten teacher has a unique opportunity to help children make a beginning in the process of inquiry through observing, questioning, investigating, and discussing. The suggested activities given in the three broad areas are to be used by teachers to suit the interests and needs of the children in individual classrooms.

Beverly Allen, Holmes Elementary School, Lincoln, Nebraska

Phyllis Conway, West Lincoln Elementary School, Lincoln, Nebraska

FROM EARTH-THROUGH AIR-INTO SPACE

Statement of the Problem

We live on a large planet called Earth.

Background

The earth on which we live is a very large planet in space. We see only a small part of the earth. The globe is a model of the earth. It shows us that the shape of the earth is almost round and that the surface is mostly covered with water. We live on land, which looks different in different places; some of it is desert, some mountains, plains, or forests. The earth constantly rotates and as it turns, half of it is facing the sun and half is in darkness. This makes our day and night.

Concepts

1. The earth is a very large ball in space.
   a. How do we know the earth is round?
   b. Does the earth move in space?
2. The earth is made up of land, water.
   a. In what ways do places on earth look different?
   b. What part of the earth is land? What part is water?
3. Gravity holds things to the earth.
   a. What keeps people from flying off into space?
   b. Does gravity help us?

Vocabulary

planet earth gravity globe rotate

Source Materials and Media

Teacher Books:

Brandwein, Paul F., et al., Concepts in Science, Grade 1, N.Y.: Harcourt, Brace & World Inc., 1966

Earth and Space Guide for Elementary Teachers, Washington, D.C.: NAEC

Parker, Bertha, Gravity, N.Y.: Harper & Row, 1962

Suggested Activities

1. Have a globe in the classroom. Point out that it is a model of the earth. Construct a toy sailboat or use a toy model. Place the sailboat on the globe and "sail" it from one side to the other. The lower part of the ship disappears from sight before the sail. This helps show that the earth is round.
2. Use the globe to distinguish land and water. Emphasize that the earth does not have a base like a model globe but that it is suspended in space.
3. Demonstrate with a planetarium that the earth is in space and that it revolves around the sun.
4. If possible, walk to a hill to observe the earth from that area.
5. Find pictures of mountains, oceans, plains, and cities to illustrate the different parts of the earth.
6. Put a stick through an orange or a hollow ball. Shine a light to represent the sun and slowly turn the round object. This will show night and day. The globe and a flashlight or lamp may also be used.
7. Stick pins in an orange or in a ball to represent how gravity keeps us on earth.
8. Hold arms outstretched and experience the "pull" that makes them want to go down. This is gravity.

Smith, et al., Science 1, River Forest, Ill: Laidlaw Science Series, 1966

Student Books:

Barnett, Lincoln, The World We Live In, N.Y.: Simon and Schuster, Inc., 1956
Childcraft, "World and Space", Chicago: Field Enterprises Corp., 1964, Volume III
Engelbrektson, Sune, Gravity At Work and Play, N.Y.: Holt, Rinehart & Winston, Inc., 1963
Holseart, Eunice, A Book To Begin on Outer Space, N.Y.: Holt, Rinehart and Winston, Inc., 1959
Goudey, Alice E., The Day We Saw the Sun Come Up, N.Y.: Charles Scribner's Sons, 1961
Lewellen, John, The True Book of Moon, Sun, and Stars, Chicago: Children's Press, 1954
Zion, Gene, All Falling Down, N.Y.: Harper and Row Publishers, 1951
Branley, Franklin M., What Makes Day and Night?, N.Y.: Thomas Y. Crowell Co., 1961

Films:

Big Sun and Our Earth, Coronet Films
What Do We See In The Sky?, Coronet Films

Filmstrips:

The Earth and the Sun, Eyegate House
Our Earth is Part of the Solar System, Eyegate House

9. Throw objects into the air and observe how they fall. Use heavy and light objects.
10. Find "gravity toys" such as a toy dump truck, egg timer, or a rocket with a parachute to demonstrate gravity.

Teacher Notes:

Student Evaluation

1. Do the children understand that the rotation of the earth causes day and night?
2. Do they realize that the major portion of the earth's surface is water and the remainder is land?
3. Do they understand the pull of gravity?

FROM EARTH-THROUGH AIR-INTO SPACE

Statement of the Problem

Air is all around the earth.

Background

Air is an essential element of our environment. Although air is an invisible mixture of gases, what it does can be observed. We can feel moving air, and see its effects on other objects. Some things are capable of flying through the air. Air flows faster above an airplane wing than beneath the wing. Thus the pressure above the wing is less than beneath the wing. The pressure from beneath lifts the airplane and keeps it aloft.

Concepts

1. Air is real.
   a. Can we see it?
   b. Can we feel it?
2. Air exerts pressure.
   a. Does air push?
   b. Do some things float in air?
3. Man can fly in airplanes.
   a. How does air help lift the plane?
   b. Could we fly without air?

Vocabulary

air airplane wing glider parachute

Source Materials and Media

Teacher Books:

Navarra, John G., et al., Today's Basic Science, Grade 1, N.Y.: Harper & Row Pub., 1963, pp. 18-28
Schnieder, Herman and Nina, Science For Work and Play, Grade 1, Boston: D.C. Heath and Co., 1955
Smith, et al., Science 1, River Forest, Ill.: Laidlaw Science Series, 1966

Suggested Activities

1. Let the children examine and manipulate a spray gun. Can you feel a stream of moving air?
2. Use the electric fan to demonstrate the movement of air. Place a pinwheel in front of the fan. Turn the fan off and on.
3. Use a hand pump to fill a basketball with air. Air presses against the sides of the ball and causes it to inflate.
4. On a windy day take the children outside. Give a large sheet of cardboard to each boy and girl. Have the children hold the cardboard broadside against the wind.
5. Blow soap-bubbles with a ring or with soap-bubble pipes.
6. Demonstrate how air holds things up with a small parachute and a glider.
7. Let the children blow up balloons.
8. Have the children do a simple experiment with a book and a toy balloon. Put the balloon on a table, with the nozzle of the balloon hanging over the edge. Place a book on top of the collapsed balloon. Now have a child blow air into the balloon.
9. Take two pieces of paper of the same size. Crumple one. Hold both pieces in the air and let them drop at the same time.

Student Books:

Bendick, Jeanne, The First Book of Airplanes, N.Y.: Franklin Watts, Inc., 1963
Brown, Margaret Wise, The Moon Balloon, N.Y.: Harper and Row Publishers, 1952
Friskey, Margaret, The True Book of Air Around Us, Chicago: Children's Press, Inc., 1953
Greene, Carla, I Want To Be A Pilot, Chicago: Children's Press, Inc., 1957
Knight, Clayton, The Big Book of Real Helicopters, N.Y.: Grosset and Dunlap, Inc., 1955
Pine, Tillie S., et al., Air All Around, N.Y.: McGraw-Hill Book Co., 1950
Tresselt, Alvin, Follow the Wind, N.Y.: Lothrop, Lee and Shepard Co., 1950
Ungerer, Tomi, The Mellops Go Flying, N.Y.: Harper and Row, 1957
Wyler, Rose, et al., Prove It!, N.Y.: Harper and Row, 1963

Films:

Air and What it Does, Encyclopaedia Britannica Films
Air All Around Us, Coronet Films

Filmstrips:

First Experiments With Air, Jam Handy
How We Fly, McGraw-Hill

10. Put a bottle of water upside down in a pan of water; blow air into the bottle with a tube. Reverse the procedure and pull the air out.
11. Let the children bring model and toy airplanes for a display.
12. Take a trip to an airport to watch the airplanes take off and land. Perhaps the children can look closely at a plane and sit in one.

Teacher Notes:

Student Evaluation

1. Do the children realize that air occupies space?
2. Have the children increased their observations of moving air?
3. Do the children understand that air pushes?
4. Are they aware that air is necessary for aircraft or conventional air flight?

FROM EARTH-THROUGH AIR-INTO SPACE

Statement of the Problem

Space is a part of our environment.

Background

Space is bigger than anything we know or understand. We are in space, our earth is in space, as are the other planets, stars, and sun in our universe. Man is interested in space travel outside the earth's atmosphere. Travel here differs in that there is no air and very little gravity. Rockets and satellites are sent into space to help us learn how to travel in space. Astronauts go into space in rocket ships to learn about man's ability to travel in space and return to earth safely.

Concepts

1. The sun, moon, stars, and our earth are in space.
   a. How big is space?
   b. What can we see in space?
2. Rocket ships can travel into far away space.
   a. How do rocket ships move away from the earth?
   b. Why can't airplanes fly into outer space?
3. Astronauts are men who go in rocket ships to outer space.
   a. How do astronauts get ready to go into space?
   b. Who are some of the astronauts?

Vocabulary

astronauts	capsule	launching pad
orbit	rockets	space

Source Materials and Media

Teacher Books:

Brandwein, Paul F., et al., Concepts in Sceince, Book 1, N.Y.: Harcourt, Brace & World, Inc., 1966, Unit 6

Jacobsen, Willard J., et al., Looking Into Science, Book 1, N.Y.: American Book Co., 1963

Suggested Activities

1. Use a planetarium or solar system mobile to illustrate the placement of the sun and planets in space.
2. Make a balloon rocket. Inflate the balloon and tape a piece of soda straw to the side. Put a length of wire through the straw and hold it vertically. Let the air out of the balloon.
3. Use a globe and a model of a Gemini or Mercury capsule and show how the capsule orbits the earth.
4. Bring models of Gemini or Mercury capsules and rocket models for display.
5. Bring pictures of astronauts, space capsules, rocket launchings, and other space events for a classroom bulletin board.
6. Whirl a ball on a string. Ask what will happen if you let go of the string, and what pulls the ball down. Go out on the playground and whirl the ball high enough so when you let go it will fly out away from everyone or inside whirl it close to the floor. Point out that it is like a rocket and that if there is enough speed, it will fly off into space.
7. Simulate the size of a space capsule by placing two large chairs side by side. Draw a line for the nose of the capsule and for the rear part which is twice as long as the nose.

Tellander, Marian, Space, Chicago:
Follett Publishing Co., 1960
Scholastic, October, 1966, "Let's Find Out."

Student Books:

Bendick, Jeanne, The First Book of Space Travel,
N.Y.: Franklin Watts, Inc., 1963
Chester, Michael, Let's Go On A Space Trip, N.Y.:
G.P. Putnam's Sons, 1963
Childcraft, "World and Space", Chicago:
Field Enterprises Corp., 1964, Vol. III
Greene, Carla, I Want To Be A Space Pilot,
Chicago: Children's Press, Inc., 1961
George, Frances, You And Space, Washington, D.C.: NABC
Holseart, Eunice, A Book To Begin On Outer Space,
N.Y.: Holt, Rinehart & Winston, Inc., 1959
Sonneborn, Ruth, The Question And Answer Book Of Space,
N.Y.: Random House Inc., 1965
Throneburg, James, Man On The Moon: Our Future In
Space, N.Y.: Alfred A. Knopf, Inc., 1961
Wassermann, Selma and Jack, Moonbeam And The Rocket
Ride, Chicago: Benefic Press, 1965

Films:

Gemini 8, NASA
Space Flight Around the Earth, Churchill Films

Filmstrips:

How An Astronaut Lives In Space, Filmstrip House
Space Trip To The Moon, Jam Handy Corp.
Rockets To Space, Jam Handy Corp.
What Is In Space?, Jam Handy Corp.

8. Watch a rocket launching on television. Keep children alerted to space events which they can watch at home.
9. Draw pictures of what you see as you stand on a hill and look into space. Imagine the night time sky and draw what you see.
10. Construct a rocket ship from cartons or cardboards. Make astronauts helmets from paper sacks or cartons.

Teacher Notes:

Student Evaluation

1. Do the children understand that our earth is in space?
2. Do they realize rockets must travel at extremely high speeds?
3. Have they increased their interest and knowledge concerning space and space travel?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAB* Do not sign your name.

1. Did you cover all material in this unit? YES_____ NO_____

   If NO which problems were covered? _____

2. Is this material suitable for the grade? YES_____ NO_____

3. Was the area too broad? YES_____ NO_____

4. Did you have difficulty obtaining materials?
   YES_____ NO_____

5. Are the concepts valuable? YES_____ NO_____

6. List Group Activities that you think are:

   Good_____

   Poor_____

7. List Individual Activities that you think are:

   Good_____

   Poor_____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format?_____

   _____ * IMPORTANT: YOUR GRADE LEVEL

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd Street

1

TEACHER'S GUIDE
AEROSPACE SCIENCE

FIRST YEAR PRIMARY

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school children on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Fred Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Dolores Painter
Madelyn Palmer
Helen Robbins
Monica Shasteen
Laura Staats
Theresa Stetz
James Winney

FLIGHT INTO SPACE

A FIRST YEAR PRIMARY AEROSPACE UNIT

Overview

"The most beautiful thing we can experience is the mysterious. It is the source of all true art and science."
- Albert Einstein -

To six-year-old children, there is excitement just in the exploration of heretofore undiscovered places in their own neighborhoods. They can appreciate the lure of adventure in a trip into the unknown -- outer space -- in an unusual kind of machine -- the spaceship.

By the age of six, most children will have asked many questions about the visible sky and will have reached some conclusions of their own. They will not have ceased to wonder about the visible sun, moon, and stars. They will now begin to ask more specific questions about plant and animal life in space, distances to other bodies in space and, perhaps, evince curiosity as to whether yet other bodies might exist in space. From questions such as these they can be led to see that scientists are also asking these questions, and, now, with the advent of rocketry, are able to get more answers. Rocketry itself prompts at least shallow inquiry as to "What makes a rocket go?" or "What makes a spaceship keep circling the earth?"

This resource unit is being offered in three broad areas: Man's quest for knowledge of the universe; His ability to project himself into space through his mastery of rocketry; and, His subsequent need and ability to take his environment with him into space. The unit need not be taught in this order nor in its entirety. Through the questions set forth an attempt has been made to lead toward the development of a teaching unit. Questions which the children ask can always be used for a more natural development. After the activities have been done in part or in entirety as befits the group, the children may form their own answers. Most will be unsophisticated but, nevertheless, should help lead toward the desired conclusion, the stated concept. It will be the responsibility of the teacher to keep the information current in this rapidly changing field of aerospace science.

A broad understanding which desirably will come from this unit is that scientists, engineers, and technicians have applied their knowledge and skill to the seemingly impossible task of flight in space, the peaceful exploration of which will be used to benefit all men.

Phyllis Aman, Mary O'Connor Elementary School, Lincoln, Nebraska
Madelyn Palmer, Brownell Elementary School, Lincoln, Nebraska

FLIGHT INTO SPACE

Statement of the Problem

Man is learning about space.

Background

Much study of the sky can be done from the earth. The naked eye, telescopes, and other instruments are furnishing information, but many questions remain unanswered. Man's curiosity has led him to seek other ways to obtain information. Being in outer space offers a better vantage point from which to view the earth and acquire more knowledge of other bodies in space. The use of rockets to boost satellites or probes far above the earth has proved highly useful. Each time a successful launch is made, knowledge grows, whether the spacecraft is manned or unmanned. Monkeys and mice have been used in experiments; instruments gather information and relay it to earth; but man's reason, insight, and judgment make him indispensable in complex missions of exploratory flight.

Concepts

1. Space extends in all directions beyond the earth.
   a. What can be seen from the earth?
   b. Is everything in space visible from the earth?
   c. How is a better perspective afforded from outer space?

2. Exploration is broadening man's knowledge of the earth and other bodies in space.
   a. How is the information acquired?
   b. How is it beneficial to man on earth?
   c. Why is knowledge of space useful?

Vocabulary

planets	explore	probe
planetarium	instruments	satellite
telescope	space	universe

Suggested Group Activities

1. Visit a planetarium.
2. Display a mobile of the solar system.
3. Place earth, atmosphere and space objects in place on bulletin board or flannelboard display.
4. Use children to represent sun, moon and earth in revolution and rotation. Words to "Farmer in the Dell" could be adapted for song to accompany.
5. Draw stars with white chalk on black paper. For comparison, do the same on white paper.
6. Shine a flashlight in a lighted classroom and again in a darkened room.
7. On playground, have child hold very small object so that it can be seen by everyone. Let child retreat until object is no longer visible.

Source Materials and Media

Teacher Books:

Bendick, Jeanne, The First Book of Space Travel, New York: Franklin Watts, Inc., 1963.
Childcraft, "World and Space", Chicago: Field Enterprises Corporation, 1964.
Cortright, Edgar M., Space Exploration -- Why and How, Washington, D. C.: U. S. Gov't Printing Office, 1964.
Dietz, David, All About Satellites and Space Ships, New York: Random House, 1962.
George, Frances, You and Space, Washington, D. C.: National Aerospace Education Council, 1964.
Jacobson, Willard Jr., Looking Into Space, New York: American Book Company, 1965, Units II and VI.
Jacobson, Willard Jr., Exploring Space, New York: American Book Company, 1965.
Lessing, Lawrence, Fortune, "Forty Miles of Information Every Day From Space," January, 1964.
NASA, "America in Space," Washington, D. C.: U. S. Government Printing Office, 1964.
NASA Facts, Washington, D. C.: U. S. Government Printing Office, 1964, 1965, 1966.
"Nimbus," Vol. II, No. 7
"Orbiting Geophysical Observatory," Vol. II, No. 13
"Project Ranger", Vol. III, No. 2
"Project Relay", G-12-62
"Project Syncom", Vol. II, No. 14
"Tiros", Vol. II, No. 12
Schneider, Herman and Nina, Science for Work and Play, Boston: D. C. Heath and Company, 1965, Chapters I, VII and IX.
Space -- Challenge and Promise, Washington, D. C.: Aerospace Industries Association of America, Inc., 1962.
Tannenbaum, Harold E., et al., Space, St. Louis: Webster Publishing Company, 1960.

8. Have child look at an outlined area on the chalkboard through viewfinder on camera. Do the same from a distance to show how much more is included in the viewfinder from a distance.
9. Show how a magnifying glass makes objects appear much larger. Discuss uses of telescope and of telescopic lens on camera.
10. Start collecting aerospace pictures. Place in box. Have child select picture from box and tell one thing he knows about it.

Suggested Individual Activities

1. Use 8 mm single concept film on Earth's Shape.
2. Draw or paint pictures of the sky.
3. View small objects under magnifying glass.
4. Look through binoculars.
5. Look through toy telescope.
6. Draw or paint pictures of satellites in space.
7. Bring pictures and stories about space shots.
8. Begin development of aerospace picture dictionary to be continued throughout unit.
9. Use Space Age Elvis Talking Book.
10. Keep calendar of space events. Use aerospace symools to mark launch dates.

Teacher Notes

Teacher Books (continued):

Tellander, Marian, Space, Chicago: Follett Publishing Company, 1960.
Worldbook, "Space Travel", Chicago: Field Enterprises Corporation, 1964, Volume XVII.

Student Books:

Burt, Olive, Space Monkey, New York: John Day Company, 1960.
Holsaert, Eunice, et al., A Book to Begin on Outer Space, New York: Holt, Rinehart & Winston Co., 1959.
Jacobson, Willard Jr., Day and Night, New York: American Book Company, 1965.
Podendorf, Illa, The True Book of Space, Chicago: Children's Press, 1960.
Powers, Richard, A Fresh Look At Clouds, New York: Franklin Watts, Inc., 1964.
Zacks, Irene, Space Alphabet, Englewood Cliffs, New Jersey: Prentice Hall, 1964.

Films:

Space Flight Around the Earth, Encyclopaedia Britannica Films, Inc.
Earth's Shape, Film Associates.

Filmstrips:

What Is Space? Jam Handy.
What Are Space Stations? Jam Handy.
What Are Satellites? Jam Handy.
How Space Science Helps Us. Filmstrip House.

Records:

Space Songs. Nasco Science Materials.

Other Media:

G. I. Joe Official Space Capsule and Authentic Space Suit, Pawtucket, R. I.: Hassenfeld Bros.
Space Age Elvis Talking Book.

Student Evaluation

1. Is the child beginning to recognize the value of space exploration?
2. Is the child building an awareness of the immensity of space?
3. Does the child want to know more about space?

FLIGHT INTO SPACE

Statement of the Problem

Man-made vehicles are launched into space.

Background

Powerful rockets, able to overcome the pull of gravity, are being used to launch manned and unmanned spacecraft from special launch sites. Spacecraft move into orbit when inertia and gravity are in balance or they proceed to the moon or other planets. They sometimes return to earth. Launching time depends upon the weather and the preparation of the vehicles and the men who control them.

Concepts

1. Rockets overcome the pull of gravity to move into space.
   a. What is gravity?
   b. How does a rocket lift off the ground?
   c. What part does weather play in a launch?

2. Spacecraft orbit or go to other bodies in space.
   a. What is an orbit?
   b. How do spacecraft stay in motion?

3. Properties of air and water can be used to effect a gentle landing.
   a. How does friction help?
   b. How does a parachute help?
   c. Why is water a good place to land?

Vocabulary

rocket	control house	gantry
launch	payload	orbit
capsule	nosecone	splash-down
launch pad	countdown	

Suggested Group Activities

1. Jump up. Notice that no energy is necessary to return to the floor.
2. Toss a ball straight up. Throw it with succeedingly more force.
3. Measure pull of gravity by weighing on scale.
4. Observe reaction when air from inflated balloon is released.
5. Tape inflated balloon on top of a toy car. Release air.
6. Tape straw to side of long, narrow, inflated balloon. Slip straw over long string. Fasten string from wall to floor. Release air.
7. Demonstrate a launch with a water rocket.
8. Twirl a ball on a rubber string.
9. Place marble in jar. With spinning motion, slowly raise arm till jar is upside down. Continue spinning to show simulated orbit.
10. Place several marbles in glass. Push glass. Note continued motion of marbles and their eventual stop after glass stops.
11. Drop two equal sized papers (1 crumpled and 1 smooth) to show comparative rate of descent as air presses against unequal surfaces.

Source Materials and Media

Teacher Books:

Bendick, Jeanne, The First Book of Space Travel, New York: Franklin Watts, Inc., 1963.
Dietz, David, All About Satellites and Space Ships, New York: Random House, 1962.
Jacobson, Willard Jr., et al., Looking Into Space, New York: American Book Company, 1965.
"Launch Vehicles", NASA Facts, Washington, D. C.: U. S. Gov't. Printing Office, Vol. II, No. 5 and Vol. II, No. 5 Supplement.
"Space Travel", Worldbook, Chicago: Field Enterprises Corporation, 1964. Volume XVII.
Tannenbaum, Harold E., et al., Earth and Space, St. Louis: Webster Publishing Company, 1960.
"World and Space", Childcraft, Chicago: Field Enterprises Corporation, 1964. Volume III.

Student Books:

Branley, Franklyn M., Rockets and Satellites, New York: Thomas Y. Crowell, 1961.
Chester, Michael, Let's Go To A Rocket Base, New York: G. P. Putnam's Sons, 1961.
De Caprio, Anne, 1, 2, New York: Grosset and Dunlap, Inc., 1965.
Hyde, Margaret O., Off Into Space, New York: McGraw-Hill Book Company, Inc., 1959.
Jacobson, Lauby and Knoicek, Rockets, New York: American Book Company, 1965.
Munch, Theodore W., What Is A Rocket?, Chicago: Benefic Press, 1965.
Powers, Richard, A Fresh Look at the Clouds, New York: Franklin Watts, Inc., 1964.
Tannenbaum, Harold E., We Read About Rockets and How They Work, St. Louis: Webster Publishing Company, 1960.

12. Attach small object to parachute. Toss and note speed of descent. Do also without aid of chute. Note effect of trapped air in parachute.
13. Drop old light bulb in pan of water, then in box of packed soil, including rocks. Compare impact.
14. Fill bottle with hot water. Pour out most of it. Rest ice cube on mouth of bottle. Discuss visibility under fog conditions.

Suggested Individual Activities

1. Collect or draw pictures of actions which illustrate the pull of gravity, as a leaf falling.
2. Observe weather. Record on calendar.

Teacher Notes:

Filmstrips:

Rockets to Space, Jam Handy.
How Gravity Works, Filmstrip House.
All Kinds of Weather, Eye Gate House.

Records:

Weather Songs, Tom Glazer, Ed. Record Sales.

Transparencies:

Space Age Science, General Aniline & Film Corp.
"Gravitational Pull", No. 258-510.
"Natural Forces", No. 258-512.
"Staging in Rocketry", No. 258-529.

Other Media:

"Air and Weather" Charts, Dansville, New York:
F. A. Owen Publishing Company.
Model -- Cape Kennedy, A Count-down Launching Pad,
Remco, Style No. 635.
Rocket Balloons, New York: Science Materials Center.
Realia.
Model -- Water Rockets, Nasco, Sol17 Two-stage.
Flannelboard cut-outs.

Student Evaluation

1. Is there evidence that the child has some understanding of propulsion?
2. Is the child aware of forces affecting vehicles returning from space?
3. Does the child understand that an object in motion has a tendency to continue its motion until it is acted upon by another force?

FLIGHT INTO SPACE

Statement of the Problem

Man is learning to live in a space environment.

Background

Surviving in space is difficult for living things which are adapted to the earth's atmosphere. Lack of atmospheric conditions means that oxygen, water, and food must be taken from earth; and the extremes of temperature necessitate some regulation. Since gravity exerts its strongest pull within the atmosphere, everything must be secured to avoid floating weightlessly in space. The careful training of the astronaut to cope with these idfferent conditions is as important as the performance of the equipment.

Concepts

1. Space has very little or no atmosphere.
   a. What do astronauts breathe?
   b. How does the lack of air affect the astronaut's performance in space?
   c. How does an air-tight suit protect the astronaut from the extreme temperatures?

2. Decreasing gravity produces a less measurable weight.
   a. What happens under weightless conditions?
   b. Why is the astronaut strapped in position?
   c. How does he eat, drink, exercise and sleep?

3. The children of today may be tomorrow's astronauts.
   a. What training is necessary?
   b. Why is good health important?
   c. Could you be an astronaut?

Vocabulary

weightlessness
tether
air conditioning
control panel

Suggested Group Activities

1. Light a candle. Cover it with a jar. Stress importance for breathing as well as burning.
2. Put hot water in a jar and in a thermos. After a short time, check the temperature of each ith a thermometer.
3. Place nozzle of portable hair dryer unit inside a child's clothing to show circulation possible with individual portable air conditioning.
4. Loop a string around the neck of a light cardboard model of an astronaut and walk very fast to simulate weightless appearance.
5. Drink water while standing upright and again while standing upside down.
6. Eat a cracker while lying prone.
7. Drink water from a squirt gun.
8. Place dry instant pudding mix in a plastic bag, squeeze to mix, and then taste.
9. Compare a typical menu at home with an astronaut's menu.
10. Try isometric exercises while sitting in a stationary position.

Source Materials and Media

Teacher Books:

Bendick, Jeanne, The First Book of Space Travel, New York: Franklin Watts, Inc., 1963.

Chester, Michael, Let's Go On A Space Trip, New York: G. P. Putnam's Sons, 1963.

Craig and Bryan, Science for You, New York: Ginn and Company, 1965. Book One.

Gilruth, Robert R., "The Making of An Astronaut", National Geographic, January, 1965, Vol. 127, No. 1.

Jacobson, Willard Jr., Exploring Space, New York: American Book Company, 1965.

NASA Educational Briefs, "Foods for Use in Space", Available from Manned Spacecraft Center, Houston, Texas.

NASA Facts, "Manned Space Flight", Available as above.

NASA Factsheet, "Astronaut Training", No. 290; "World Where Nothing Falls Without A Push", No. 77058, Available as above.

"Space Travel", Worldbook, Chicago: Field Enterprises Corporation, 1964. Vol. XVII.

Wells, Robert, What Does An Astronaut Do?, New York: Dodd, Mead and Company, 1961.

"World and Space", Childcraft, Chicago: Field Enterprises Corporation, 1964. Volume III.

Student Books:

Greene, Carla, I Want To Be A Space Pilot, Chicago: Children's Press, 1961.

Hyde, Margaret O., Off Into Space!, New York: McGraw-Hill Book Company, Inc., 1959.

Kumin, Maxine, Speedy Digs Upside Up, New York: G. P. Putnam's Sons, 1964.

Thayer, Jane, The Pussy Who Went To The Moon, New York: William Morrow and Company, 1960.

Suggested Group Activities (continued)

11. Plan and construct a simulated space capsule large enough to accommodate a child. Use materials available.

Suggested Individual Activities

1. View 8 mm single concept films.
2. Construct a space helmet.
3. Listen to record, "Let's Play Astronaut".
4. Dramatize a trip into space.
5. Tell original stories about an imaginary trip into space.
6. Draw imaginary animals, plants, and people that might live on other planets.
7. Make "Activated Astronaut".

Teacher Notes:

Films:

Reaching Into Space, International Film Bureau.

Filmstrips:

How An Astronaut Live in Space, Filmstrip House.
Getting Ready for a Space Trip, Jam Handy.
Space Trip to the Moon, Jam Handy.
Man In Space, Walt Disney, Encyclopaedia Britannica Films, Inc., (select appropriate frames)
Flight Around the Moon, Walt Disney, Encyclopaedia Britannica Films, inc., (select appropriate frames)
Flight Into Space, Walt Disney, Encyclopaedia Britannica Films, Inc., (first 30 frames only)
Experimental Weightlessness, Film Association of Los Angeles.
Free Fall In Space, Film Association of Los Angeles.

Records:

Let's Play Astronaut, The Listen and Learn Record Company.
Manned Mercury Spaceflight, Hassenfeld Bros., Inc.

Student Evaluation

1. Does the child understand that man must take his own environment into space?
2. Is the child aware that an astronaut must be trained to perform the most routine daily functions?
3. Does the child recognize the importance of good health, education and training in whatever vocation he may pursue?
4. Has the child added aerospace terminology to his vocabulary?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAB* Do not sign your name.

1. Did you cover all material in this unit? YES_____ NO_____

   If NO which problems were covered?

   _____

2. Is this material suitable for the grade? YES_____ NO_____

3. Was the area too broad? YES_____ NO_____

4. Did you have difficulty obtaining materials?

   YES_____ NO_____

5. Are the concepts valuable? YES_____ NO_____

6. List Group Activities that you think are:

   Good_____

   Poor_____

7. List Individual Activities that you think are:

   Good_____

   Poor_____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format?_____

   _____

* IMPORTANT: YOUR GRADE LEVEL

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd Street

2

TEACHER'S GUIDE
AEROSPACE SCIENCE

SECOND YEAR PRIMARY

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school students on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts, which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Freo Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Laura Staats
Dolores Painter
Madelyn Palmer
Helen Robbins
Monica Shasteen
Theresa Stetz
James Winney

FLIGHT THROUGH AIR

A SECOND YEAR PRIMARY AEROSPACE UNIT

OVERVIEW

The purpose of this unit is to stimulate and guide the children in a constantly growing understanding of flight in air and its relationship to every day living. To fly in the air like a bird has always been the dream of man, but dreams cannot lift man off the earth. Through experimenting with balloons and aircraft, man flew. Now he flies higher and faster than birds, he can fly where there is no air.

In the study of the three major problems of this unit - Air is a Real Material, Weather and How it Affects Flight, Different Kinds of Aircraft - the children will gain a background which will help them to understand flight in air. Each concept is under a major problem area and is stated briefly with the idea that the teacher will develop the understandings according to the interest and abilities of their groups.

Many activities and media have been suggested. It is expected that the teacher will use the ones which are applicable to the unit as it is developed by each teacher and his pupils. Current publications are a source to be used at all times. It may be helpful to begin the unit with recent important developments in flight.

Dolores Painter, Sheridan Elementary School, Lincoln, Nebr.

Joeline F. Beck, May Morley Elementary School, Lincoln, Nebr.

FLIGHT THROUGH AIR

Statement of the Problem

Air is a real material.

Background

The force which makes flight possible is atmospheric pressure acting upon the wings of the airplane. Scientists use this principle in designing airplanes. Air surrounds the earth and is called "atmosphere". Without this atmosphere a person could live only about ten minutes.

We know that air has temperature, as some days the air is very warm, and in the winter it is often very cold. Warm air is lighter than cool air. Temperature changes affect the flight of aircraft. Updrafts cause planes to rise and down drafts cause aircraft to drop. Flying horsepower pulls the plane out of these drafts.

Air has weight and pressure. Air pressure makes a soda straw work. We use compressed air to fill tires. Atmospheric pressure acting on the wings hold the aircraft in the air.

Concepts

1. Air takes up every available space.
   a. Where is space?
   b. Does air have weight?
   c. What would happen if there was no air around you?
   d. Can you see air?
   e. Is air real?

2. Changes of temperature are affected by heat and cold.
   a. What takes place when air is heated and cooled?
   b. Does warm air weigh less than cool air occupying the same place?
   c. In which direction does warm air move? Cold air?

3. Air pressure is all around you, even though you may not notice it.
   a. Does air press in all directions?
   b. How is air put into bicycle tires?
   c. How does air pressure help you drink through a straw?

Suggested Group Activities

1. Get an empty bottle. Turn it over on its side. Push it down quickly into a deep pan or tank full of water. Watch the bubbles come up. The bubbles are bubbles of air. The bottle was not empty in the beginning, it was full of air.
2. Use a thermos bottle to illustrate the value of a vacuum.
3. Use a rose bowl. Fill it with marbles, then sand, then water which will cause bubbles of air. Children should note as each item is added that there is still space available.
4. Put a small cloth in the bottom of a large glass. Turn the glass upside down and push it straight down into a pan of water. Then pull the glass out of the water. The cloth is dry because the air did not let the water into the glass.
5. Fit a balloon to the top of a pop bottle. Heat the bottle. What happens? (No air has entered - air has expanded.) Cool the bottle in ice and observe what happens. (Cold air contracts.)
6. An electric light bulb that has been burning for a few minutes heats the air above it and causes the air

Vocabulary

expand	gases
contract	inflate
pressure	deflate
invisible	thermos
vacuum	atmosphere
oxygen	mercury
nitrogen	

Source Material and Media

Teacher Books:

Hyde, Margaret, Flight Today and Tomorrow,
New York: Whittlesey House, 1962
Jacobson, Willard J. et al., The Air Around You,
New York: American Book Co., 1965
Mandell, Mariel, Science For Children,
New York: Sterling Publishing Co., 1961
Pacilio, James, Discovering Aerospace,
Chicago: Children's Press, 1965

Student Books:

Dowling, Thomas L. et al., The New Seeing Why,
Philadelphia: Winston & Co., 1958
Pine, Tillie S. et al., Air All Around,
New York: Wittlesey House, 1960
Podendorf, Illa, The True Book of Science Experiments, Chicago: Children's Press, 1963
Bonsall, George, The How and Why of Weather,
New York: Grosset and Dunlap, 1960

to rise. Sprinkle a tiny amount of talcum powder or cornstarch into the air a few inches above the bulb and watch as the powdered air is pushed upward.
7. Place a card over a glass filled with water. Turn the glass upside down. What happens?
8. Do the boiled egg, milk bottle experiment. See The Air About Us, p. 19.

Others
The Air About Us, pp. 5-9, 20-21
Science Around You, pp. 50-51
The Air Around You, pp. 2-7, 12, 21
Science For Children, pp. 9
The New Seeing Why, pp. 116-123
The True Book of Science Experiments, pp. 44-45
The How and Why of Weather, pp. 16-17

Suggested Individual Activities

1. Blow up balloons to show air is present. Pinch the balloon. It is air that you feel.
2. Illustrate various items that need air in order to be useful.
(balls, tires, balloons, any inflatable objects.)
3. Illustrate objects air can hold up.(leaf, kite, parachute, etc.)
4. Hold a piece of thin paper in both hands. Have another child push his finger against one side of the paper. You've pushed a hole. Take another piece of paper. This time use a finger from each hand and push at the same spot. The pressure is equal on both sides of the paper. The paper should not tear.
5. Hang two balloons a few inches apart and blow between them. The balloons move together. By causing air to move, you lessen air pressure. The faster air moves, the less pressure it has. Airplanes rise from the ground because of this.
6. Keep an illustrated dictionary of complete unit.

Others:
Flight Today and Tomorrow, pp. 25-27
Science For Children, pp. 5-18

Films:

Air and What It Does - Encyclopedia Britannica,
The Air All Around Us, Y.A.
How Air Helps Us, Coronet

Study Prints:

Air and Weather - 12 prints
F. A. Owens Pub. Co., Dansville, N.Y.

Student Evaluation:

1. Do the children understand that:
   a. Air is everywhere?
   b. Air has weight and pressure?
   c. Air is useful?

2. Have the children learned that:
   a. The cooling and heating of air causes changes in weather?
   b. Air can move in all directions?
   c. Warm air weighs less than cold air occupying the same space?

3. Do the children know:
   a. Air presses in all directions?
   b. Air pressure is useful?

FLIGHT THROUGH AIR

Statement of the Problem

How do different types of aircraft serve different purposes?

Background

Our daily lives are becoming increasingly geared to the use of airplanes as a source of travel. Indications are that aviation travels will continue to grow at a rapid rate.

Men have always wanted to fly. When they were successful they did not fly like we think of flying, they floated like a cloud. Balloons were used in early air flight. They float in the air because they are lighter than the air they push aside. They are used in a number of ways. Armies have used them, they have been used to explore the atmosphere, they carry weather instruments into the air to gather weather information.

In later years when the Wright brothers invented the flying machine few people wanted to risk flying or to spend money to develop aircraft. An airplane flies because air moving across its wings causes an upward force called lift. Lift is not enough to fly the plane. There must be a forward movement supplied by the propellor or engine. Many kinds of planes have been developed since that first flight -- airplanes that can fly longer distances and at higher altitudes. Passenger planes, cargo planes and helicopters are some of our most useful planes.

Designers and engineers set no limits on the size of future planes. There will be changes in the wings--perhaps planes without wings. There will be planes that will land and take off vertically.

Concepts

1. There are aircraft lighter than air.
   a. Do you know of any aircraft lighter than air?
   b. Why does a balloon fly?
   c. Could a balloon carry people?
   d. What are some uses of balloons?
   e. How does a dirigible differ from a balloon?
2. The flow of air over and under a wing helps support the weight of a flying machine. This discovery made the airplane possible.
   a. What makes an airplane fly?
      (1) What is lift?
      (2) What is gravity?
      (3) What is thrust?
      (4) What is drag?

Suggested Group Activities

1. Make flash cards showing pictures of parts of planes.
2. Children may dramatize a jet take-off by reaching high over-head from a squatting position and pulling up on toes as a rubber band is snapped. Other dramatic activities: spinning the propeller, making parachute jumps, or making a forced landing.
3. Tie a handkerchief into a parachute form and tie a small plastic toy to it. Teacher may drop it from the window and allow the children, standing in the school yard, to observe how it floats to the ground.
4. See how lift worked. "Discovering Aerospace", p. 30
5. See jet propulsion work, "Discovering Aerospace", p.34
6. See effect of drag. "Discovering Aerospace", p. 52

b. How do wings and propellers affect the flight of a plane?
c. What makes an airplane go up and down?
d. How does an airplane turn?
e. How does the pilot land the plane?

3. Helicopter flights are different from flights of propeller planes.
   a. How does the helicopter fly?
   b. How is it different?
   c. What are some uses of the helicopter?
4. Air transportation for tomorrow is changing.
   a. What types of flights are being planned? (VTOL, space stations, X15, supersonic, etc.)

Vocabulary

aircraft	aileron
dirigible	flaps
helicopter	fuselage
propeller	compartment
cargo	cockpit
lift	rotor
thrust	vertical
drag	supersonic
gravity	landing gear
rudder	navigation lights
elevator	parachute
fin	jet propulsion
	Wright brothers

Source Materials and Media

Teacher Books:

Highland, Harold, The How and Why of Flight, N.Y.: Wonder Book, 1961
Hyde, Margaret, Flight Today and Tomorrow, N.Y.: McGraw Publishing Co., 1962
Pacilio, James, Discovering Aerospace, Chicago: Children's Press, 1965

7. Make a joy stick and rudder bar, "Discovering Aerospace", p. 67
8. Construct a simple toy airplane using cartons or small boxes. Have model show main parts: wing, propeller, tail, wheels and fuselage. You may need these materials: cardboard for propeller and wings, milk bottle lids for wheels.
9. Make an airplane large enough to get into. Use orange crates or heavy cardboard cartons. Cartons can be cut apart for wings and tail: a pinwheel could be used for the propeller. The finished airplane could be painted and named.
10. Take a field trip to the Federal Aviation Agency. Observe types of planes, weather bureau and hangars.
11. Invite a pilot to talk to the children about aviation.

Suggested Individual Activities

1. Make a scrapbook of airplanes.
2. Draw a mural showing the history of flight.
3. Hold a large sheet of paper by one edge. It will hang straight down as long as you are standing still. Run with it and the paper will be pushed upward. Objects moving through the air are pushed upward by the force of air against their under surfaces.
4. Make a simple helicopter. You will need a card four inches by six inches, two thumbtacks, a pencil six inches long, a ruler and scissors. Make a five-inch cut lengthwise through the center of the card. Bend each section back from the uncut end of the card, in opposite directions. Attach the helicopter to the top of the pencil with two thumbtacks. Drop the helicopter into the air. Note how the rotor blades of the model helicopter spin. This spinning causes an upward thrust which makes possible a slow descent.

Source Materials and Media, contd.

Poole, Lynn & Gray, Balloons Fly High,
N.Y.: McGraw Publishing Co., 1961
Sutherland, Lucille, Let's Read About Airplanes,
St. Louis: Webster Publishing Co., 1958

Student Books:

Adelson, Leone, Fly Away At The Airshow,
N.Y.: Wonder Book, 1962
Chace and Haile, About the Pilot of a Plane,
Chicago: Melmont Publishing Co., 1959
Greene, Carla, I Want to be An Airplane Hostess,
Chicago: Children's Press, 1960
Lewellen, John, Tommy Learns to Fly,
N.Y.: Crowell Publishing Co., 1956
Phleger, Fred, Ann Can Fly,
N.Y.: Beginner Books Inc., 1959

Films:

Airplanes-Principles of Flight, Coronet Films, Chicago
Billy's Helicopter Ride, Coronet Films, Chicago
Airplane Trip by Jet, E. B. F. (3rd Edition)
425 No. Michigan Avenue, Chicago
The Science of Flight, G. C. Burns Film Co.,
17160 Tulsa St., Granda Hills, Calif.

Filmstrips:

Airplane Jets and Rockets, Jam Handy
2821E Grand Blvd., Detroit, Michigan
Aviation and Mr. World, Univ. of Nebr.
How we Fly, McGraw-Hill Film Library,
330 W. 42nd, N.Y., N.Y. 10036
Kitty Hawk to Canaveral, Pop. Science Pub. Co., N.Y. N.Y.
Man Learns to Fly, E.B.F., Wilmette, Ill.

Source Materials and Media, contd.

Transparencies:

The Story of Flight, #29E, 3M Co., St. Paul, Minn.

Teacher Notes:

Student Evaluation

1. Do the children know:
   a. That there are aircraft lighter than air?
   b. Why a balloon flies?
   c. The uses of balloons?
   d. How a dirigible differs from a balloon?
2. Do the children understand:
   a. The meaning of lift, gravity, thrust, and drag in relationship to the flight of an airplane?
   b. How wings and propellers affect the flight of planes?
3. Do the children have a knowledge of the different types of aircraft?
4. Are the children aware of current changes in aircraft and what is being planned for future flights?

FLIGHT THROUGH AIR

Statement of the Problem

Weather and how it affects flight.

Background

Airmen should never undertake a cross-country flight without first studying a weather map and consulting a forecaster if one is available. Also necessary for the pilot is a generalized concept of the physical processes that occur in the atmosphere.

Surface wind direction determines the direction of take-off and landing while velocity and gustiness determine the hazard.

The atmosphere is a mixture of gases whose main components are oxygen, nitrogen, and water vapor. The pull of gravity causes the greatest density of air to be at the earth's surface and least density at the outer limit.

Meteorologists gather information about the weather conditions and predict what the weather will be tomorrow, next week, or even next month. They track destructive storms and tell people when to expect floods.

Concepts

1. Weather affects the flight of planes.
   a. What kinds of weather do we experience?
   b. What causes changes of weather?
   c. Why does weather affect flying?

2. The weather bureau helps the pilot.
   a. What is the weather bureau and what is its work?
   b. What information does the pilot receive from the weather bureau?

3. Weather can help the pilot.
   a. What kind of day is best for flying?
   b. Why do pilots take off into the wind?

Vocabulary

forecaster	fog	nimbus	visibility
atmosphere	sleet	stratus	ceiling
predict	thunder	precipitation	weather vane
storms	lightning	haze	weather bureau

Suggested Group Activities

1. Discuss today's weather and how it affects and influences our daily lives.
2. Observe wind direction by watching movement of leaves on trees, holding a handkerchief high, watching the movement of flags, clouds, smoke from chimneys, etc.
3. Discuss why a pilot would check weather conditions before he goes into the plane.
4. Discuss high and low pressures with children. See Weather by Waller and Funk, a good simple explanation of high and low pressures.
5. Discuss various weather instruments that the weather man uses. (Thermometer, barometer, rain guage, etc.)
6. Familiarize children with the four major types of clouds. (Cumulus, stratus, cirrus, and nimbus.)
7. Discuss the types of weather that could be dangerous for flying. (Hurricanes, tornadoes, fog, etc.)
8. Visit the weather bureau, if possible.
9. Discuss types of information the weather bureau makes available to pilots.

Vocabulary, cont.

floods	clouds	rain guage
tornado	cirrus	thermometer
hail	cumulus	barometer

Source Material and Media

Teacher Books:

Barnard, et al, Science Life, N.Y.: MacMillan & Co., 1962
Bonsall, George, The How and Why of Weather,
N.Y.: Wonder Books, 1960
Dowling, Thomas L., et al, The New Seeing Why,
Phil.: Winston & Co., 1958
Hyde, Margaret, Flight Today and Tomorrow,
N.Y.: McGraw Publishing Co., 1962
Mallinson, et al, Science 2,
Morristown, N.J.: Silver Burdett, 1962
Schneider, Herman and Nina, Science for Here and Now,
Boston, Mass., D. C. Heath & Co., 1955
Smith, et al, Science 2, River Forest, Ill.,
Laidlow Science Series, 1965
Weather Pamphlet, Chicago, World Book Encyclopedia,1960

Student Books:

Dowling, Thomas L. et al, The New Seeing Why,
Phil.: Winston & Co., 1958
Schneider, Herman and Nina, Science For Here and Now,
Boston, Mass.: D. C. Heath & Co., 1955

Films:

How Weather Helps Us, Coronet
The Clouds Above, Bailey, 6509 De Longpre Ave.,
Hollywood 28, California
Water in the Air, E.B.F., Wilmette, Ill.
Tornado, Norwood Films, 926 New Jersey Ave., N.W. Wash. D.C.

Filmstrips:

Seasons, Weather, McGraw Hill, 330 W. 42nd, N.Y.
Primary Science Series-Weather, E.B.F., Wilmette, Ill.
First Experiments with Air, 5 fs, Jam Handy, Detroit, Mich.

Suggested Individual Activities

1. Ask children who have flown to describe weather conditions during their flight.
2. Learn to read the thermometer. Hang one outside your window. Record temperature daily.
3. Keep a simple daily weather chart. Use symbols to designate kinds of weather.
4. Make collages of aviation and weather - using various materials such as miniature planes. (String, cotton, paper, straw, etc.)
5. Make a weather vane. Put a long pin or nail up through a spool. Set a soda straw on the pin so that it can turn freely. Put a paper arrow on the straw with a spot of glue.
6. Collect news items about weather. Make a collective news bulletin board of "Weather in the News".
7. Have children make use of the filmstrips by using the Viewmaster.
8. Culminating activity - group characterization of weather and its elements. See Weather Pamphlet, The World Book Encyclopedia, p. 12

Source Material and Media, Cont.

Transparencies:

Clouds-Earth, Science & Weather, #273,
3M Co., St. Paul, Minn.

Student Evaluation:

1. Have the children gained in understanding of:
   a. How weather affects the flights of planes?
   b. The causes of weather change?
   c. The various kinds of weather?
2. Do the children understand:
   a. How the weather bureau helps the pilot?
   b. That the pilot should check with the weather bureau before a flight?
   c. The theory of taking off into the wind?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAB.* Do not sign your name.

1. Did you cover all material in this unit? YES_____NO_____

   If NO which problems were covered? _____

2. Is this material suitable for the grade? YES_____NO_____

3. Was the area too broad? YES_____NO_____

4. Did you have difficulty obtaining materials? YES_____NO_____

5. Are the concepts valuable? YES_____NO_____

6. List Group Activities that you think are:

   Good_____

   Poor_____

7. List Individual Activities that you think are:

   Good_____

   Poor_____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format?_____

   _____

* IMPORTANT: YOUR OWN IDEAS

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd St.

3

TEACHER'S GUIDE
AEROSPACE SCIENCE

THIRD YEAR PRIMARY

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school students on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts, which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Fred Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Laura Staats
Dolores Painter
Madelyn Palmer
Helen Robbins
Monica Shasteen
Theresa Stetz
James Winney

AIRCRAFT, SPACECRAFT, AND THE EFFECT OF WEATHER

A Third Year Primary Aerospace Unit

OVERVIEW

Man's dream of flight, his desire to reach the stars, is as old as mankind itself. But desires and dreams alone cannot lift a man off the earth. We need men of vision who are willing to face repeated experimentation and possible failure. Many people considered man's first attempts at flight as foolish, but his determination led to final success. The intervening years from Kitty Hawk to supersonic flight cover less time than an average life expectancy. Flight has progressed from the unusual to the commonplace, from occasional flights to a network of skyways criss-crossing in all directions, from the pasture landing strip to concrete runways at airports capable of handling one hundred and twenty flights per hours.

General aviation accounts for approximately seventy-five percent of the flights being made today. These comparitively small planes "fill" the atmosphere below five thousand feet, shuttling back and forth on criss-crossing lanes of flight. Commercial and military aircraft generally travel at higher altitudes.

Many satellites have been rocketed into space. As they orbit the earth some send back space information, some photograph the earth and its cloud cover, and some relay messages from continent to continent.

Man has rocketed into space in the Mercury and Gemini programs. These flights, as well as airflights, depend upon weather conditions.

This unit was designed to give children some knowledge of aircraft, spacecraft, and how flights are affected by the weather. It is not to be considered all-inclusive nor restrictive. It is, rather, to be used as a guide from which a teacher may proceed, deleting or adding material to fit the unit to the interests and background of a particular group. Children of today are as thrilled by the thought of flight as were the dreamers of old. Therefore the questions suggested under each problem can be expected to come naturally from the children.

Science is learned through investigating and experimenting. Other processes which are valuable in making experiences meaningful and long lasting are: observing, classifying, inferring, drawing conclusions, evaluating, communicating and measuring. The use of these processes helps them become natural to the child, providing him with an orderly way of thinking and and doing. Science, however, is also to be enjoyed.

Eleanor Buller, West Lincoln Elementary School, Lincoln, Nebraska
Mary Evans, Randolph Elementary School, Lincoln, Nebraska
Monica Shasteen, St. Teresa's Elementary School, Lincoln, Nebraska
Theresa Stetz, Huntington Elementary School, Lincoln, Nebraska

AIRCRAFT, SPACECRAFT, AND THE EFFECT OF WEATHER

Statement of the Problem

Man is solving the problems of air travel.

Background

Man's flight through air has changed from a dream to reality.

Since people require different types of aircraft to fulfill their needs, airplanes are designed to be used in different ways. The style of the craft depends upon its usage. Some styles are gliders, propeller craft, and jets, all can be used for cargo, passengers, recreation and experimentation.

For successful flight man has learned to overcome drag and gravity by giving an airplane lift and thrust. He has also learned to control yaw, pitch, and roll to produce stable flight.

Who can foresee the new problems that will arise as speed and distance of flight increases?

Concepts

1. An airplane in flight is constantly subjected to four forces: gravity, drag, friction, and thrust.
   a. What causes weight?
   b. What force overcomes weight?
   c. What is thrust?
   d. Why are varying degrees of thrust necessary?

2. An aircraft in motion will continue in the same direction until acted upon by some force.
   a. What is pitch?
   b. What is yaw?
   c. What is roll?
   d. What causes a plane to have these motions?
   e. How are the above motions controlled?

3. The intended use of an aircraft determines it size and style.
   a. How does a crop sprayer use his plane?
   b. What kind of plane is used by a business man?
   c. How do commercial airline planes differ?
   d. How is a helicopter different from an airplane?

Suggested Group Activities

1. Collect pictures of various types of airplanes for a booklet or bulletin board.
2. Discuss the sources of movement used by airplanes and plan an exhibit of available models.
3. Use a balloon to show the principles of jet propulsion.
4. Fold paper to make a sailplane to observe the principle of glider flight.
5. Listen to resource people on their uses of planes (crop spraying, business, fun, etc.)
6. Make a chart showing the parts of a plane. Point out the parts that are used in control and their functions.
7. Visit an airport or a flight service station. Watch a pilot flight-check a plane and/or operate the controls of the rudder, ailerons and elevators.

Suggested Individual Activities

1. Assemble an airplane model.
2. Interview (in person or by letter) one who uses an airplane in his work or for recreation.

Concepts, cont.

e. How can an airplane land on water?
f. How are sailplanes used?
g. How do propeller craft differ from jets?
h. What would be the advantage of a super-sonic jet?
i. Can a jet engine be used for flight in space?
j. What other uses are there for planes?
k. How has the airplane enlarged our community and decreased the size of the world?
l. Which planes are we talking about when we say military, commercial, general aviation?

Vocabulary

airstrip	cockpit	pitch
aileron	controls	pontoon
airpocket	drag	pressurized cabin
air stream	flap	radio beam
airway	fuselage	roll
amphibian	glide	rudder
aviation	hangar	supersonic
biplane	lift	turbojet
ceiling	instrument flying	yaw

Source Materials and Media

Teacher Books:

American Heritage History of Flight, N.Y.: J. B. Lippincott Co., 1961
Loosbrook, John, and Skinner, Richard ed., The Wild Blue, N.Y.: G. P. Putnam's Sons, 1961.
NASA Fact Sheets
Floherty, John J. and McGrady, Mike, Whirling Wings, N.Y.: J. B. Lippincott Co., 1961

Suggested Individual Activities, cont.

3. How to demonstrate lift: Hold a sheet of paper at nose level, six inches from your mouth, so it flaps forward. Blow over the top of the paper. The paper will rise because air moving over the curve has less pressure.
4. Encourage the children to observe birds taking off, flying, gliding, and landing.
5. Take two pieces of paper of the same size. Crumple one piece. Stand on chair and drop both pieces, making sure flat piece is held parallel to floor. Flat piece floats down more slowly, showing that larger surfaces provide greater air support.
6. Demonstrate drag by running with a piece of cardboard, holding it flat against the breeze. Notice the resistance. Repeat the experiment but hold the cardboard edge-wise. (Since air offers resistance, airplane wings are tapered and thin.)
7. Build a balsa glider. Reader's Digest, Treasury for Young Readers, 1963, pp. 68-69)
8. Make a parachute of paper or cloth. Show how it slows the descent of an object fastened to it.
9. Make transparencies from colored pictures (planes, parts of planes etc.)

Teacher Notes:

Media Continued

Student Books:

Anderson, A. m., and Johnson, R. E., Pilot Jack Knight, N.Y.: Harper and Row, 1960
Coombs, Charles, Aerospace Pilot, N.Y.: William Morrow Company, 1964-(Adv.)
Greene, Carla, I Want To Be An Airplane Hostess, Chicago: Children's Press, 1960-(easy).
Highland, Harold Joseph, How and Why Book of Flight, N.Y.: Grosset and Dunlap, 1961
Jacobsen, Willard F., Lauby, Cecilia J., Kinicek, Richard D., The Air Around You, N.Y.: American Book Co., 1965
Lewellen, John, Tommy Learns to Fly, N.Y.: Thomas Y. Crowell Co., 1956
May, Julian, Show Me the World of Modern Airplanes, Fremont, Mo.: Pennington Press, 1959
Norling, Jo, Pogo's Jet Ride, N.Y.: Rinehart and Winston, 1961-(easy).
Reader's Digest, Treasury for Young Readers, Pleasantville, N.Y.: The Reader's Digest Association, 1963, pp. 38-43 inc.
Thurber and Durkee, Exploring Science, Boston: Allyn Bacon, 1964, (Book Four, p. 209).
Young Peoples Science Encyclopedia, Vol. 1, Chicago: Children's Press.

Films:

Billy's Helicopter Ride, Coronet
How An Airplane Flies, Series of 6 Films
Shell Oil Co.

1. Lift
2. Drag
3. Thrust
4. Flight
5. Controls
6. Stability

Media Continued

Filmstrips:

Kitty Hawk to Canaveral, Popular Science
How Gravity Works, color, 35 fr., NASA
Man Learns To Fly, Walt Disney
Man In Flight, Walt Disney

Transparencies:

The Story of Flight, 3 M, Number 29

Pictures of Historic Planes:

16 pictures, Free from United Air Lines,
School and College Service,
O'Hare International Airport,
P.O. Box 8800,
Chicago,
Illinois, 60666

Records:

The Wright Brothers

Student Evaluation:

1. Does the student understand how man is overcoming the forces of nature encountered when flying an aircraft?
2. Does the student understand which parts of an airplane are used to control its various motions while in flight?
3. Does he have a working knowledge of the various types of aircraft and their uses?

AIRCRAFT, SPACECRAFT, AND THE EFFECT OF WEATHER

Statement of the Problem

Man is meeting the challenge of space travel.

Background

For thousands of years man has marveled at and speculated about the stars and planets in the heavens. Today he recognizes the heavens as outer space and, in addition to marveling and speculating, man is experiencing closer contact with the planets. This became a possibility with the development of rocket power.

Thrust is the measurement of a rocket's power. A large spacecraft requires a great amount of thrust to overcome earth's gravitational pull.

Rockets are propelled by solid or liquid fuels; the type of rocket determines which is used. The launch vehicle that will send man to the moon will require a complicated three stage rocket. Each stage will give additional thrust.

Once in space, control and guidance of the craft are of prime importance. This is accomplished by both manual and remote control.

The rocket has merely opened the door. Who knows? Man may one day visit galaxies other than his own.

Concepts

1. The amount of thrust needed for a launch vehicle to send a payload into space is related to the weight of the spacecraft.
   a. Why do the launch vehicles of the Mercury, Gemini and Apollo require different sized rockets?
   b. What is a rocket stage?
   c. Why and how are several rocket stages used?
   d. Why do spacecraft require more thrust than aircraft?

2. Power to launch spacecraft is provided by several kinds of fuel.
   a. Which of the launch vehicles used solid fuel? Liquid fuel?
   b. How does solid fuel provide its thrust?
   c. Why is a liquid fuel rocket more complicated?
   d. What can you say about the thrust needed after a spacecraft is in orbit?

Suggested Group Activities

1. Use a straight-sided jar over the top of a burning candle to show that fire needs oxygen to burn. (Fuel requires oxygen to burn.)
2. Write a playlet pretending you are on the moon or are in a space capsule.
3. Discuss the similarity in the shape of rockets and how this helps them move through the atmosphere.
4. To demonstrate the forces that keep a satellite in orbit, swing a ball on a string in a circular motion. (The string represents gravity.)
5. Draw imaginary views as seen from a spaceship.
6. Write original lyrics about space or the astronauts to a familiar tune.
7. Make a class booklet on current space activities.
8. Have a child on roller-skates throw ball. (action, reaction).
9. Demonstrate that some materials protect us from heat by laying a large circle of asbestos over a hot plate. The top side will be barely warm.

Concepts, cont.

e. What do you think is in the future for space travel?
f. What other fuels might be used for future space ships?
g. Can jet engines be used for space travel?

3. Spacecraft depend upon both manual and remote control.
   a. How do computers help space travel?
   b. What is remote control and how is it used in space flight?
   c. How does manual control differ?
   d. How are roll, pitch and yaw of a spaceship controlled?
   e. Why did the Gemini capsule turn its broad end to the front as it re-entered the earth's atmosphere?
   f. What is ablation and how does it help re-entry?
   g. What is a drogue chute?
   h. What are some safety measures used in space flight?
   i. What uses other than travel are being made of spacecraft?

Vocabulary

ablation	guided missile	NASA
astronaut	hatch	nosecone
booster rocket	heat shield	orbit
capsule	launch	pad
carrier rocket	launch vehicle	payload
cosmic rays	lox(liquid oxygen)	propellent
contour couch	manual control	remote control
count-down	interplanetary flight	satellites
drogue chute	interstellar flight	tracking
gantry	multi-stage rocket	weightlessness

Suggested Individual Activities

1. Report on the different types of launch vehicles that have been used as to size, number of stages, fuel used, and the payload. (Refer to NASA Facts-United States Launch Vehicles).
2. Read reference books as to the origin of spacecraft names.
3. Make models of various rockets. (Balsa, paper craft).
4. Imagine you were living on the moon ten years from now. Describe your home, the kind of work you're doing, and what you would do for fun.
5. Bring a toy operated by remote control and demonstrate how it maneuvers.
6. Make a time line, recording the names, dates, and the number of orbits of manned space flights.
7. Make a collection of space poems or write original space poems.
8. Demonstrate the resistance which the spacecraft encounters as it re-enters the atmosphere. Pin a large sheet of cardboard to the front of the child's clothing. Is it easier to run with or without it?
9. Place a marble or small ball inside a glass and, with the glass on its side, move it swiftly along the surface of a table. Stop the glass suddenly and observe the motion of the marble. What force moves marble on after glass stops? (Inertia) Why does marble slow and stop later? (Friction of air and table).
10. Make a diorama of a soft lunar landing (the Surveyor) including the moon's environment. A spaceman and his mooncraft might also be used.
11. Use film strips to help solve individual questions.
12. Make transparencies of exceptional colored pictures.
13. Draw pictures of or construct a model of a space station of the future.
14. Construct a Gemini capsule large enough for two children to sit in.

Source Materials and Media

Teacher Books:

Costa, Arthur L., Space, Darien, Conn.: Teachers' Publishing Corporation, 1964.
Dewey, Anne Perkin, Robert Goddard, Space Pioneer, Toronto-Boston: Little, Brown and Co., 1962.
Jacobsen, Willard J., Lauby, Cecilia J., Konicek, Richard D., Exploring Space; Living in Space; Rockets, New York: American Book Company, 1965.
Shippen, Katherine B., A Bridle For Pegasus, New York: The Viking Press, 1964.
We Seven by the Astronauts Themselves, New York: Simon and Shuster, 1962.

Pamphlets:

NASA Materials - available from:
Educational Programs and Services Office
Manned Spacecraft Center
Houston, Texas

1. America in Space
2. 25 Giant Steps to the Moon
3. NASA Astronauts
4. Manned Space Flight -- Project Apollo, Projects Mercury and Gemini

National Geographic Magazine Articles available from:
National Geographic Society
Publication Order Department
Washington, D. C. 20036

1. "Flight of the Freedom 7" and "The Pilot's Story: A Personal Report", September, 1962.

Teacher Notes:

Media (continued)

Life Magazine also carries excellent articles on the astronauts.

Student Books:

Bendick, Jeanne, The First Book of Space Travel, New York: Franklin Watts, 1963.
Crosby, Alexander L. and Larrick, Nancy, Rockets Into Space, New York: Random House, 1959.
Dewey, Anne Perkin, Robert Goddard, Space Pioneer, Toronto-Boston: Little, Brown and Co., 1962.
Jacobsen, Willard J., Lauby, Cecilia J., Konicek, Richard D., Exploring Space; Living in Space; Rockets, New York: America Book Company, 1965.
Knight, Clayton, How and Why Wonder Book of Rockets and Missiles, New York: Grosset & Dunlap, 1963.
Priestly, Lee, Rocket Mouse, New York: Abelard Schuman, 1961.
Tannenbaum, Harold E. and Stillman, Nathan, We Read About Rockets and How They Work, New York: McGraw-Hill Book Co., 1960.

Films:

Manned Space Flight, (NASA)
Gemini VIII, (NASA)
John Glenn Story, (NASA)

Filmstrips:

How Space Science Helps Us, (NASA)
Space Flight, Part I, Physical Problems, (NASA)
Space Flight, Part II, Human Problems, (NASA)
Space Rockets, (Jam Handy), (NASA)

Records:

Space Songs. #0312, NASCO Science Materials
P.O. Box 560,
Fort Atkinson,
Wisconsin, 53538

Viewmaster:

America's Man in Space
Moon Rockets and Guided Missiles
Man on the Moon

Student Evaluation

Do the children understand:
1. That the launch vehicles require different amounts of thrust?
2. Why several rocket stages are used?
3. That various fuels may be used by space vehicles?
4. How oxygen is obtained in space?
5. The differences between remote and manual control?
6. Why a satellite remains in orbit?
7. The purpose of various space shots?
8. That space exploration is only in its infancy?

AIRCRAFT, SPACECRAFT AND THE EFFECT OF WEATHER

Statement of the Problem

Weather and its forecasting affect air and space travel.

Background

Weather is one of the first things a man must consider when he plans an air or space flight. His attempts to control weather have met with very little success, but by extended observations and study of its movements man has learned to forecast weather with a reasonable degree of accuracy.

Weather is caused by changes in temperature, air pressure, and humidity. In the Central Plains weather moves in a general west to east direction. Winds blow from areas of high air pressure to areas of low air pressure. They blow in large circular patterns caused by the rotation of the earth. Winds move in a clockwise direction around high pressure areas; in a counter-clockwise direction around low pressure areas.

Weather observations are made at many weather stations throughout the United States. This information is relayed to central weather bureaus where it is compiled and made available to the general public in the form of weather maps and forecasts. The work done by weather bureaus helps make air and space flight safe as well as possible.

Weatherwise, the future looks bright. Weather satellites (such as the Tiros) are constantly sending back photographs of the earth's cloud cover. Weather satellites now being planned hold great promise for more accurate weather forecasting in the future.

Concepts

1. Air moves from high to low pressure areas in a large circular pattern.
   a. What do we mean by air pressure, highs, lows?
   b. What causes the circular motion of winds blowing from highs to lows?
   c. In which direction does weather in your area move?
   d. What do winds from each of the four main directions mean to your area, weatherwise?
   e. Which instruments are used to give us weather information?

Group Activities

1. Keep a weather calendar, observing and recording weather concepts being studied. Make observations at same time daily.
2. Collect magazine pictures clearly showing clouds. Identify the cloud type.
3. Make a water cycle chart.
4. Note that warm air rises. Observe smoke rising from chimneys, vapors from roof vents and roof tops, and heat waves from furnace vents.

f. How does a barometer help us know what kind of weather to expect?

2. Certain clouds are the forerunners of particular weather conditions.
   a. What are the four main types of clouds?
   b. Which are the fair weather clouds? Storm clouds?
   c. What is an updraft? How does it affect flight?
   d. Why are some hailstones very large?
   e. How does the temperature of the air over large bodies of land or water affect air movement in winter and summer?

3. Weather can be forecast and therefore flights can be scheduled.
   a. How does a pilot check the weather before a flight?
   b. What effect does weather have upon launching a space ship? an airship?
   c. What are the common symbols for rain, hail, snow etc., as used on weather maps?
   d. What are isobars and what do they tell us?
   e. How are balloons used at the weather stations to collect weather information?
   f. How are satellites used by the U. S. Weather Bureau?
   g. How can a pilot protect himself against the dangers of turbulent weather?
   h. How can we protect ourselves from the weather elements?

Vocabulary

air pressure	forecast	rain guage
anemometer	forerunners	stratus
barometer	high	symbols
contract	hurricane	temperature
cirrus	isobars	thermometer
cumulus	low	tornado

5. Blow air into two paper bags. Tie loosely leaving a loop. Hang the bags one inch from each end of a yardstick. Balance on the back of a chair. Mark the point of balance on the yardstick. Place one bag in refrigerator; place one bag in the sun (or oven) to heat. Several hours later hang bags in original position on yardstick. Using the same point of balance, observe that cold air is heavier.
6. Show condensation of water vapor on the outside of a cold glass (dewpoint). As the glass warms, the droplets evaporate into the air and become water vapor again.
7. Take a field trip to a weather bureau to observe how weather data is received and distributed.

Individual Activities

1. Construct a weather vane. (Jacobsen, Lauby, Konicek; Thinking Ahead in Science).
2. Make a simple hygrometer. Immerse a four inch circle of white blotting paper in a solution containing two parts cobalt chloride to one part common salt. Hang it near a window. When moisture content of the air is low the circle will be light blue; when moisture content is high, circle will be pink.
3. Construct an anemometer. (Young People's Encyclopedia, Vol. 1, 1964.)
4. Make a wind sock. (Young People's Science Encyclopedia, Vol. 19, 1964) Use outdoors to check on daily wind direction.
5. Construct a rain gauge.
6. Make a chart of cloud types using cotton on blue paper.
7. Make a thermometer. Put colored water in bottle fitted with one-hole stopper containing a piece of glass tubing. How do temperature changes affect water in the tube?
8. Make a barometer. Procure a U-shaped glass tube with one short side. Put the short side of the tube into a one-hole stopper. Fit the stopper firmly in a

Vocabulary, contd.

evaporation	nimbus	weather vane
expand	precipitation	water cycle
		wind sock

Source Material and Media

Teacher Books:
Childcraft, World and Space, Vo. III, Chicago: Field Enterprises Educational Corporation, 1964
Young People's Science Encyclopedia, Vol. 19 Chicago: Children's Press Inc., 1962
NASA Fact Sheets -- Tiros, Nimbus

Student Books:
Bonsall, George, How and Why Wonder Book of Weather, N.Y.: Wonder Books, 1960
Campbell, Ethel, The Wind, Nature's Great Voice, Minneapolis: T. S. Denison & Co., Inc., 1959
Gallant, Roy, Exploring the Weather, Garden City, N.Y.: Garden City Books, 1957
Goudey, Alice, The Good Rain, N.Y.: Aladdin Books,1950
McGrath, Thomas, Clouds, Los Angeles: Melmount Publishers Inc., 1950
Meyer, Jerome, Picture Book of Weather, N.Y.: Lothrop, Lee and Shepard Co. Inc., 1958
Sandman, Howard, Who's Afraid of Thunder? The Story of Weather, N.Y.: Sterling Publishing Company Inc., 1953
Waller, Leslie, Weather, N.Y.: Holt, Rinehart and Winston Inc., 1959

Young People's Science Encyclopedia, Vol. 19

Individual Activities, contd.

bottle half filled with water and hang upside down. Note level of water in tube as air pressure varies.

Media, Cont.

Films:
The Flight Decision, FAA
A Storm Called Maria, Walt Disney
Tiros II Experimental Weather Satellite, NASA
What Makes Clouds, Encyclopeadia Britannica

Filmstrips:
Weather Changes, (Fundamentals of Science, Eye Gate Filmstrips)
Fundamental Elements of Weather, (Eye Gate)

Transparencies:
Earth Science Weather, 3M Company

Study Prints:
Air and Weather, F. A. Owen Publishers

Student Evaluation

Do the children understand:

1. The significance of highs and lows in reference to winds and fair or stormy weather?
2. Which instruments are used to measure weather conditions?
3. The four main types of clouds and their value for forecasting?
4. Why and how a pilot checks the weather before a flight?
5. The significant symbols of a weather map?
6. The relation of weather to the safety of aircraft and spacecraft?
7. How weather satellites will affect future forecasting?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAB.* Do not sign your name.

1. Did you cover all material in this unit? YES_____ NO_____

   If NO which problems were covered? _____

2. Is this material suitable for the grade? YES_____ NO_____

3. Was the area too broad? YES_____ NO_____

4. Did you have difficulty obtaining materials? YES_____ NO_____

5. Are the concepts valuable? YES_____ NO_____

6. List Group Activities that you think are:

   Good_____

   Poor_____

7. List Individual Activities that you think are:

   Good_____

   Poor_____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format?_____

   _____

* IMPORTANT: YOUR GRADE L[illegible]

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd St.

4

TEACHER'S GUIDE
AEROSPACE SCIENCE

FOURTH GRADE

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school students on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts, which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Fred Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Laura Staats
Dolores Painter
Madelyn Palmer
Helen Robbins
Monica Shasteen
Theresa Stetz
James Winney

THE MOON AND BEYOND

A FOURTH GRADE AEROSPACE UNIT

OVERVIEW

"Heavens are for reaching and descending; And though a thousand falls have left their scars, Man yet will build his tower to the stars."
--Stanfors Sternlicht

As children look about them, the mysteries of the universe call to them. They need to develop some understandings of this universe, for, with the satellites, the probes, the explorations into space, this, the universe, is their environment. In this unit we will attempt to explore three major problems that man has encountered or will encounter in looking to the moon and beyond. These problems are: (1) Man Learns About the Universe; (2) Man Explores Space; and (3) Man Looks to the Future.

The suggested books, audio-visual materials, and activities range through various levels of difficulty. It is expe ted that teachers will select and use only those which are suitable for their pupils.

Since the televising of space launches has become so frequent, it is suggested that, if possible, viewing a manned space shot initiate this unit.

Gerald Anderson, Dodge Elementary School, Grand Island, Nebraska
Laura Staats, Ruth Pyrtle Elementary School, Lincoln, Nebraska

THE MOON AND BEYOND

Statement of the Problem

Man studies the Nature of the Universe.

Background

The most obvious units of matter in the universe are the stars and the galaxies into which the stars are grouped. Around our star, the sun, are the additional units of matter called the planets, the comets, and the asteroids. That the distances between matter in space may have more meaning, new units of measure are used -- the light year and the astronomical unit. Though the vast regions of space are often thought to be empty, actually the regions contain gases (mostly hydrogen) and small particles of dust. Ordinarily this interstellar gas and dust are spread so thinly through space that the best vacuums produced by man contain more matter per unit volume.

Over 300 years ago Sir Isaac Newton defined several principles governing the movement of all bodies in the universe in his laws of motion and of universal gravitation. Newton's first law of motion states that every body tends to remain in a state of rest or of uniform motion unless acted upon by some force. This tendency of matter is called inertia. The inertia of an orbiting planet tends to separate the planet from the sun. The gravitational attraction between the planet and the sun acts as a balancing force continually acting and keeping the planet in orbit about the sun.

Concepts

1. The sun is at the center of the solar system.
   a. How do planets revolve about the sun?
   b. How are the nine planets of our solar system varied?
   c. What is now known of the earth's satellite, our Moon?
2. As Man's methods and tools of observation improved, his estimate of the size of the universe increased.
   a. How far is it to the moon? to the sun?
   b. How do the moon and earth compare in size?
   c. How do the sun and earth compare in size?
   d. What is a light year? an astronomical unit?
3. Our universe is constantly changing.
   a. Why can we see the Big Dipper all year and the other stars only in some seasons?
   b. Why does the moon have different shapes?
   c. What tools or instruments are used by the astronomers to observe the universe?

Suggested Group Activities

*Activities that can be carried on through the year.

*1. Bulletin Board: "Early Astronomers". Permit students to add to this as they read of the contributions of Galileo, Copernicus, Kepler, Newton, Herschel, Lowell.
2. Using styrofoam balls, wires, and pins construct a model of the solar system. Or, see Laidlaw, Science 4, page 174, for another example of a model.
3. Visit the nearest planetarium to observe the constellations in our winter skies.
4. Read and discuss some of the ancient myths and legends about the moon. Contrast these ideas to the actual information about the moon which was obtained by Surveyor. (Life, July 1, 1966.)
5. Compute a light year; an astronomical unit. Chart distances in both measures to the moon, the sun, and the other planets.

d. What changes does a star go through as it develops from a very young to a very old star?

Vocabulary

asteroid	astrology	astronomer
astronomical unit	cosmic dust	comet
constellation	Milky Way	galaxy
light year	orbit	moon
myths	"Red" giant	planet
planetarium	solar	revolve
rotate	sun	spectroscope
star	"White" dwarf	telescope
universe		

Source Material and Media

Teacher Books:

Bergaust, Erik, Saturn Story, N. Y.: G. P. Putnam's Sons, 1962.
Bromley, The Sun, Star Number One, N. Y.: Thomas Y. Crowell Co., 1960.
Emme, Eugene, A History of Space Flight, N. Y.: Holt, Rinehart & Winston, Inc., 1965.
Ley, Willy, Beyond the Solar System, N. Y.: Viking Press, 1964.
Life: July 1, 1966, "The True Color of the Moon".
Smith, Blecha, Sternig, Science 4, River Forest, Illinois: Laidlaw Science Series, Tchr. Ed.
von Braun, Wernher, The Mars Project, Urbana, Illinois: University of Illinois Press. 1962.

Student Books:

Bell, Thelma and Bell, Corydon, The Riddle of Time, N. Y.: Viking Press, 1963.
Branley, Franklyn M., The Nine Planets, N. Y.: Thomas Y. Crowell Co., 1958.
Dowling, T. I., The New Explaining Why, N. Y.: Holt, Rinehart & Winston, Inc., 1958.

6. Using the scale, 1 inch = 100,000 miles, model the state of Nebraska and the surrounding states in colored clay. Using a camera, photograph the model from a height of 10 feet. What can you see?
7. Use a Trippensee Planetarium to demonstrate revolution and rotation.
8. Collect and assemble "Space News" bulletins.
9. Make a constellation project. See Laidlaw, Science 4, page 178.
10. Report on instruments used by astronomers — telescope, cameras, spectroscope, satellite.

Suggested Individual Activities

1. Pupil swings a small ball at the end of a string to feel the effect of inertia of a revolving object. Have pupil let go of the ball and observe its path. Remind him that gravity will pull the ball to the ground.
2. Chart the phases of the moon over a 30-day period.
3. Find out the significance of each planet's name.
4. Observe the night sky on the next 5 moonlit nights at 7 o'clock. Do you see the same objects each night? Are they in the same place? Explain any change.
5. Bring binoculars to school. Observe a distant object. How does it appear to change?
6. Observe the sun through a cardboard sun viewer. DO NOT look directly as the sun.
7. Make a black one-inch line on a sheet of white paper. Have a classmate hold the paper before you, then back slowly away. Does the line change?
8. Observe -- the coils of a toaster glow red; the filament in a light bulb glows white; wood burns with a yellow - flame; and natural gas burns blue. Color is an indication of temperature.
9. Report on one of the ancient legends about the constellations.

Knight, The First Book Of Mars, N.Y.: Watts, 1966
Nephew W., Beyond Mars, N.Y.: Putnam, 1960
Priestley, Lee, Rocket Mouse, N.Y.: Abelard-Schuman, 1961
Smith, Blecha, Sternig, Science 4, Laidlaw, 1965
Tellander, Marian, Space, Chicago:
Follett Publishing Co., 1960
Ware, Kay, Let's Read About Stars, N.Y.:
McGraw-Hill Book Co., 1957
Wyler, Ames, New Golden Book of Astronomy,
Wayne, N.J.: Golden Press, 1965

Films:
Beyond Our Solar System, Coronet Instr. Films,
65 East Water, Chicago, Ill.
Exploring the Night Sky, Encyclopedia B I, Wilmetta, Ill.
Mars and Beyond, Walt Disney, Buena Vista, Calif.
The Moon, E.B.F., Wilmette, Calif.
The Solar Family, E.B.F., Wilmette, Ill.
The Sun's Family, McGraw Hill, N.Y., N.Y.
This is the Moon, McGraw Hill, N.Y., N.Y.
Exploring the Moon, McGraw Hill, N.Y., N.Y.
Stars, International Film Bur., Chicago, Ill.
Orbiting Solar Observatory, NASA

Filmstrips:
The Earth and Its Neighbors in Space
Encyclopedia Brittannica, Wilmette, Ill.
The Sun, Encyclopedia Brittannica, Wilmette, Ill.
The Solar System Series, McGraw Hill Book Co.,
330 West 42nd St., New York, N.Y.
Wonders of the Sky,
Eye Gate House, Archer Ave., Jamaica, N.Y.

8 mm Single Concept Films:
Comet Orbits
Eclipse of the Sun
Eclipse of the Moon
Mars and Jupiter
Film Associates
11559 Santa Monica Blvd., Los Angeles, Calif.

Source Material and Media (cont.)

Transparencies:
Eclipse of the Sun
ETA-S1 Hubbard Scientific Co.,
Northbrook, Ill.
The Solar System
800-1 Instructo

Celestial Globe

Slides - as available

Teacher Notes:

Student Evaluation:

1. Do the students understand the order within the solar system?
2. Are the students expressing creativity with their use of the media?
3. Do the children have some idea of the vast distances beyond our earth?
4. Do the children show interest in our universe?
5. Do the children realize that our universe is constantly changing?

THE MOON AND BEYOND

Statement of the Problem

Ingenuity, courage and perseverance are essential for man's conquest of space.

Background

The idea of flying was first expressed by early man in legend and mythology. Some of these legends which traveled the currents of time are: The Winged Men of Egypt; the Winged Bulls of Assyria; Sinbad, the Sailor, and his Roc; the Arabs and Their Flying Carpets; Daedalus and his Son, Icarus; Pegasus, the Winged Steed.

Concepts

1. Man was first inspired to fly by observing birds in flight.
   a. How does a bird fly?
   b. Who were some of the first men to try to fly like a bird?
   c. What did some of these machines look like?
2. Concrete ideas were established over an extended period which contributed greatly to further flight by man.
   a. What did da Vinci contribute to flight development?
   b. How were gliders developed and who were the people involved with these aircraft?
   c. What experiments did the Montgolfier Brothers perform?
3. Heavier-than-air flight was developed over a relatively short period of time by brave and determined men.
   a. Who were some of the early men who understood heavier-than-air flight?
   b. What were the problems which prevented success for these men?
   c. Who developed the first plane that flew under it's own power?
   d. Who were some of the flyers who became famous for their deeds?

Suggested Group Activities

1. Observe wing action of birds in flight. Observe wing and feather structure.
   Watch drift of lighter than air materials; cotton, hair, dandelion and milkweed seed.
2. Construct a paper glider. Watch the drift of this glider in an air current. (Exploring Science, p. 234, Allyn & Bacon, 1960)
3. Present reports on famous flyers or people. (Roger Bacon, Leonardo da Vinci, Montgolfier Brothers, Otto Lilienthal, Octave Chanute, Samuel Langley, Wright Brothers, Charles Lindbergh, Amelia Earhart, Howard Hughes.)
4. Make a time line.
5. Take a field trip to the local airport to observe airplanes in flight; inspect them on the ground.
6. Visit a weather station.
7. Secure weather maps available at weather stations.
8. Read together the story of the X-15 rocket-plane.
9. Investigate Newton's third law of motion. Demonstrate with a balloon filled with air.
10. Watch for and bring for display current events. (Space travel experiments change our concepts of rocket speeds and distances, constantly.)
11. Find information on space stations. Help children visualize life in a space station by setting up an imaginary one and deciding what it should contain.

4. Pilots study all phases of weather.
   a. Why do pilots need to know weather conditions?
   b. Why are weather bureau stations usually located at airports?
   c. How is the direction of the wind shown at the airport?

5. Man is exploring space by using the rocket.
   a. How does a rocket work?
   b. Why were rockets developed?
   c. Why is Robert Goddard known as the "father of rocketry"?
   d. How does a rocket differ from a jet?
   e. Why does a rocket have three main parts?
   f. What are some of the objects man has rocketed into space?
   g. What has been the purpose of rocket exploration?

Vocabulary

aileron
atmosphere
centrifugal
drag
elevator
environment
friction
fuselage
gravity
lift
mission
nose cone
orbit
payload
propellant
radar
rudder
satellite
thrust
velocity

Source Materials and Media

Teacher Books:

Bernardo, James V., Aviation in the Modern World, New York: E. P. Dutton & Co., 1960

12. From the magazine A Walk in Space, dramatize conversation of flight directors and the astronauts McDivitt and White.
13. Make the simple line and bar graphs which would show our rapid advances in aeronautics. (Aerospace Arithmetic, p. 12.)
14. A pilot might explain the theory of flight to the class.

Suggested Individual Activities

1. Pretend that you are an astronaut. Write a diary.
2. Construct a weather vane.
3. Make a wind sock.
4. Find pictures of astronauts in space. Construct a model space suit.

Teacher Notes

Branley, Franklyn M., Exploration of the Moon, New York: Natural History Press, 1964.
Emme, Eugene M., A History of Space Flight, Holt, Rinehart and Winston, Inc., 1965.
Ley, Willy, Harnessing Space, New York: The MacMillan Company, 1963.
Murchie, Guy, Song of the Sky, Boston: Houghton Mifflin Co., 1954.
Thomas, Shirley, Men of Space, New York: The Chilton Company, 1960-1965.

Student Books:

Coombs, Charles, Aerospace Pilot, New York: William Morrow & Co., 1964.
Dewey, Anne Perkins, Robert Goddard -- Space Pioneer, Boston: Little, Brown & Co., 1962.
Douty, Esther M., Ball In The Sky, New York: Holt, Rinehart and Winston, Inc., 1956.
Floherty, John J., Whirling Wings, Philadelphia: J. P. Lippincott & Co., 1961.
Lewellen, John, Jet Transports, New York: Thomas Y. Crowell Co., 1955.
Schneider, Leo, Space In Your Future, New York: Harcourt, Brace & World, Inc., 1961.
Shelton, William Roy, Flights of the Astronauts, Boston: Little, Brown & Co., 1963.
von Braun, Wernher, First Men to the Moon, New York: Holt, Rinehart & Winston, Inc., 1960.
Throneburg, Man on the Moon, Alfred A. Knopf, 1961.
Wells, Robert, What Does An Astronaut Do? Dodd, Mead & Co., 1961.
Wyler, Bard, Science Teasers, Harper & Row, 1966.
Hutchinson, Spielberg, Space Travel, New York: Franklin Watts, Inc., 1963.
Frasier, MacCracken, Decker, Exploring Together, New York: Singer, 1965.

Source Materials and Media (continued)

Films:

Project Apollo (NASA)
Proud Conquest (NASA)
Step Into Space (NASA)
The John Glenn Story (NASA)

Filmstrips:

Mars and Beyond, Walt Disney
Trip to the Moon, Encyclopaedia Britannica

8 mm Concept Films:

Experimental Weightlessness, Film Associates
Free Fall in Space, Film Associates

Student Evaluation

1. Do the students understand the basic principles of aircraft flight?
2. Are the contributions of early pioneers in aircraft development recognized by the pupils?
3. Are the children aware of the various organizations which make flying safe?
4. Are space and space travel familiar topics in conversations between children?
5. Do children show more interest in current news of accomplishments in space and space travel?

THE MOON AND BEYOND

Statement of the Problem

Scientific research in the aerospace field will have a direct bearing upon our way of living in the future.

Background

For several years airplanes have been flying at speeds up to 600 miles an hour. These planes can span the continent in about six hours. The introduction of these great planes to commercial service brought about changes of unprecedented proportions. But even these advanced jet planes are not the last word in air travel. Far from it!

Man has also sent more than 300 instrumented satellites and probes into space. They have orbited the earth, landed on the moon, investigated the planet Venus, the sun, and the space between the near planets. Man himself has made many trips into space. Whether a trip to the moon will become a reality for the ordinary citizen is still problematical. In the meantime, however, engineers and scientists are busy on other fascinating vehicles, passenger-carrying planes of incredible performance.

Concepts

1. Man plans faster planes, larger airports, and extended air routes.
   a. What measures can be taken to insure safe transportation at greater speeds?
   b. Why will heliports serve as an essential part of the transportation network?
   c. Why is the speed at which travelers pass from one area to another important?

2. New vehicle designs and advanced fuel developments will be necessary for space flights of the future.
   a. Why is greater speed necessary as we extend our frontiers deeper into space?
   b. Why do we need to develop stronger material for spacecraft construction as speed is increased? What new kinds of materials are being developed?

Suggested Group Activities

1. Design an imaginative airplane of the future. Use paste sticks and construction paper, or other materials.
2. Construct an imaginary moon colony.
3. Dramatize the vacation visit of an earth family to a moon colony.

Suggested Individual Activities

1. Make a model airport and heliport.
2. Examine a U.S. map, and place stars at points where great cities might share a large airport.
3. Demonstrate rocket power. Attach a balloon to a balsawood model plane.
4. Show how electricity is generated by placing iron filings near a moving electric current.
5. Make a list of the things you need to take with you on a trip to the moon.

c. In what ways may we measure speed and distance in the future?
d. What types of energy might be developed for use in advanced spacecraft?
e. What is the need for, or the objective of space exploration?
f. What provisions would be necessary for an extended trip into space?

Source Materials and Media

Teacher Books:

The Astronauts Themselves, We Seven, New York: Simon & Schuster, 1962
Beauchamp, Wilbur, et al., Science is Experimenting, Chicago: Scott Foresman and Co., 1962
Bergaust, Erik, Saturn Story, New York: G. P. Putnam's Sons, 1962
Branley, Franklyn, Exploration of the Moon, Garden City, New York: Doubleday & Co. Inc., 1964
Branley, Franklyn, The Sun, Star Number One, New York: Thomas Y. Crowell Co., 1960
Emme, Eugene, A History of Space Flight, New York: Holt, Rinehart and Winston, 1965
Gann, Ernest K., Fate is the Hunter, New York: Simon & Schuster, 1961
Ley, Willy, Beyond the Solar System, Dayton, Ohio: The Viking Press, 1962

Student Books:

Bendick, Jeanne, The First Book of Space Travel, New York: Franklin Watts, Inc., 1964
Branley, Franklyn, A Book of Satellites for You, New York: Thomas Y. Crowell Co., 1958
Branley, Franklyn, Exploring By Astronaut, New York: Thomas Y. Crowell Co., 1961

6. Silly Quiz - Science Teasers, by Wyler and Baird.
   a. Who can go around the world faster than an astronaut?
   b. If an astronaut sat on a tack while he was in orbit, would the tack stick him?
   c. When is a baseball like a satellite?
   d. Do you move around the sun faster in the daytime, or in the night?
7. Make a 3-D bulletin board on jets, rockets, or missiles.
8. Make a frieze of "Now and When" of air transportation.
9. Make a graph showing the number of miles you could travel in one day (24 hours) by:
   a. walking
   b. pony express
   c. car
   d. streamlined train
   e. propeller-driven airplane
   f. jet airplane
10. Viewmaster--"A Moon Colony." After viewing the pictures the pupils may write a personal account of their visit to the moon. Pupils may discuss the reel--was it realistic according to known facts about the moon? What representations are not factual?

Teacher Notes:

Burt, Olive, Space Monkey, New York: John Day Co., 1960
Chester, Michael, Let's Go on a Space Trip, New York: G. P. Putnam's Sons, 1963
Coombs, Charles, Aerospace Pilot, New York: William Morrow Co., 1964
Coy, Donald, Stations In Space, New York: Holt, Rinehart, and Winston, Inc., 1960
Dietz, David, All About Satellites and Space Ships, New York: Thomas Y. Crowell, 1958
Highland, Dr. Harold, How and Why Book of Planets and Interplanetary Travel, New York: Grosset and Dunlap, Inc., 1963

Films:

Trip to the Moon, EBF
Exploring the Moon, McGraw Hill
Friendship 7, NASA
John Glenn Speaks to Young America, NASA
GT-3 First Manned Gemini Mission, NASA
Manned Space Flight, NASA
X-15, NASA
Song of the Clouds, Shell Oil Co.

Transparencies:

Mariner II - Flight to Venus, General Aniline
Project Apollo Spacecraft, General Aniline and Film Corp.

Student Evaluation:

1. Do the children understand the rapid advances being made in aircraft travel?
2. Do they recognize the need for these changes?
3. Are the children aware of current accomplishments being made in space?
4. Do the children show imagination in activities related to space?
5. Are some of the problems involved in the further exploration of space recognized?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAB.* Do not sign your name.

1. Did you cover all material in this unit? YES_____ NO_____

   If NO which problems were covered? _____

2. Is this material suitable for the grade? YES_____ NO_____

3. Was the area too broad? YES_____ NO_____

4. Did you have difficulty obtaining materials? YES_____ NO_____

5. Are the concepts valuable? YES_____ NO_____

6. List Group Activities that you think are:

   Good_____

   Poor_____

7. List Individual Activities that you think are:

   Good_____

   Poor_____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format?_____

   _____ * IMPORTANT: YOUR GRADE LEVEL

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd St.

5

TEACHER'S GUIDE

AEROSPACE SCIENCE

FIFTH GRADE

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school students on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts, which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Fred Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Laura Staats
Dolores Painter
Madelyn Palmer
Helen Robbins
Monica Shasteen
Theresa Stetz
James Winney

FLIGHT THROUGH AIR AND SPACE

A Fifth Grade Aerospace Unit

OVERVIEW

This aerospace unit, FLIGHT THROUGH AIR AND SPACE, considers man in flight by means of propeller plane, jet plane, and rocket and space ship.

Most fifth grade children need little encouragement to begin their study of air and space travel. It is hoped that these materials might be presented to children to further fire their imagination, to encourage in-depth study, and to widen their exploration of present day and future space travel.

It is hoped that each fifth grade teacher working with this unit will realize that emphasis has been placed on developing the science process skills of observing, classifying, communicating, and measuring, rather than on specific subject matter.

It is urged that pupils use a variety of ways to gather data including interviews, books, field trips, films, and realia.

SILVER SHIPS*
Mildred Plew Meigs

There are trails that a lad may follow
When the years of his boyhood slip;
But I shall soar like a swallow
On the wings of a silver ship.

Guiding my bird of metal,
On with her throbbing frame,
Floating down like a petal,
Roaring up like a flame.....

*Revised Edition of the ARBUTHNOT ANTHOLOGY OF CHILDREN'S LITERATURE
Scott, Foresman and Company, Chicago, 1961

Luella Craig, Sheridan Elementary School, Lincoln, Nebr.
Fred Esser, Hawthorne Elementary School, Lincoln, Nebr.
Winona Malolepszy, St. Theresa Elementary School, Lincoln, Nebr.

FLIGHT THROUGH AIR AND SPACE

Statement of the Problem

A skillful pilot must understand the forces which act upon his plane, and how to use them most advantageously. How does his propeller airplane fly?

Background

Every minute of the day and night about twelve airplanes take off somewhere in the world on regularly scheduled flights. Today airways join the great cities of the world and span oceans and continents in just a few hours.

In addition to these scheduled flights there are many aircraft engaged in general aviation flying.

The youth of today must have an appreciation and awareness of the history, practical effect, and future potential of this transportation giant.

Becoming acquainted with one type of airplane (i.e., propeller) will help children understand how and why all planes fly.

Concepts

1. Man has used many types of aircraft in his attempt to fly.
   a. What are some of the stories of man's early attempts to fly?
   b. What was the importance of da Vinci's research and planning?
   c. How did the first balloonist fly?
   d. How does a dirigible differ from a balloon?
   e. How does a glider soar?
   f. In what way did the Wright brothers use gliders?
   g. How did early aviation progress?
   h. How does the autogyro fly? The helicopter?
2. The forces of lift, gravity, thrust, and drag affect flight.
   a. What is ~~dift~~? Thrust? Gravity? Drag?
   b. What is the general shape of an airfoil? How does it affect lift?
   c. How does a plane move through the air? (Consider stall, glide, loop the loop, roll, crabbing).
3. Aircraft instruments and movable controls on the plane help the pilot control the plane in its flight through air.

Suggested Group Activities

1. Review the history of flight. This might include some aircraft that are lighter-than-air (balloons and dirigibles) and some aircraft that are heavier-than-air (airplanes and helicopters).
2. Display pictures and models of aircraft. Encourage children to bring models.
3. Through the process of experimentation encourage the discovery of the forces that cause an airplane to rise and fly. (Theory of flight).
4. Through the process of observation children can discover the different kinds of plane designs. Why are the wings made differently? Compare older models with newer models.
5. Make models of aircraft--label the parts. Discover how each part works and helps to control the plane when in flight.
6. Visit an airport and observe the parts of a real plane. Consider asking a pilot to be your guide. (Instrument panel, fuselage, wings, propeller, tail section, landing gear).

a. What are the axes of rotation of a plane?
b. What controls the airplane around each axis?
c. What instruments are found in the cockpit and how do they help the pilot control his plane?

Vocabulary

aerodynamics	aeronautics	aileron	airfoil
air pocket	air stream	airway	altimeter
amphibian	aviation	biplane	ceiling
cockpit	controls	dive	drag
fin	fuselage	lift	stability
Link Trainer	panel	pitch	rudder
thrust	yaw	instrument flight	

Source Materials and Media

Teacher Books:

Bryan, Leslie, et al., Fundamentals of Aviation and Space Technology, Urbana, Ill: Univ, of Ill. 1966
Hyde, Margaret O., Flight Today and Tomorrow, N.Y.: Whittlesey House, 1962
Pacilio, James V., Discovering Aerospace, Chicago: Children's Press, 1965

Student Books:

Bryan, Leslie, et al., Fundamentals of Aviation and Space Technology, Urbana, Ill.: Univ. of Ill. 1966
Cooke, David C., Flights That Made History, N.Y.: G.P. Putnam's Sons, 1961
Green, Carla, I Want To Be A Pilot, Chicago: Children's Press. 1957
Highland, Harold J., The How and Why Wonder Book of Flight, N.Y.: Grosset and Dunlap, 1961
Hyde, Margaret O., Flight Today and Tomorrow, N.Y.: Whittlesey House, 1962
Joseph, James, You Fly Jet, N.Y.: Dodd, Mead & Co. 1965
May, Julian, Modern Airplanes, Cleveland: Pennington Press, 1959

7. Bring in resource people such as a pilot or an airline stewardess.

Suggested Individual Activities

1. Construct or illustrate an airport. This could be done by a child who has visited an airport and then explained to the class. Include the wind sock, air strips, control tower, and miniature model planes.
2. Read about important work done by such people as Charles Lindbergh, Wright Brothers, Amelia Earhart, and others.
3. Make reports and prepare experiments to show:
   a. How does an airplane turn?
   b. What makes an airplane go up and down?
   c. How can you demonstrate lift?
   d. What do the instruments tell the pilot?
   e. How do pilots fly in all types of weather?
   f. What is a cold front? Warm front?
   g. Learn to read an hourly sequence report. These sequence reports may be obtained from your local weather bureau station and Federal Aviation Agency communication station.

Teacher Notes:

McFarland, Kenton D., Airplanes How They Work
N.Y.: Putnam's Sons, 1966
Webster Beginner Science Series, Let's Read About Airplanes, St. Louis: Webster Div.--McGraw-Hill, 1958

Films:

Airplanes: How They Fly, color, 1 1/4 reels,
Young America Films
Airplanes: Principles of Flight, b/w, 1 reel,
Coronet Films
How An Airplane Flies, b/w, 2 reels each,
Four parts, Shell Oil Co.
Man in Flight, b/w, 1 1/2 reels, Walt Disney Films
The Science of Flight, color, 1 reel,
G.C. Burns Film Presentation

Filmstrips:

How We Fly, McGraw-Hill
Kitty Hawk to Canaveral, Popular Science Pub. Co.
Man in Flight, Walt Disney, (Space and the Atom Series) Encyclopaedia Britannica Films
What Makes Engines Go?, N.Y.:
Popular Science Publishing Co.

Transparencies:

History of Flight, 3 M Company
Parts of an Airplane, 3 M Company

Student Evaluation

1. Do the pupils appreciate and understand the importance of the airplane and the effect it has had on our modern day world?
2. Do they understand how "shapes" and "forces" enter into the operation and flight of the aircraft?

FLIGHT THROUGH AIR AND SPACE

Statement of the Problem

The jet has made it possible for man to go higher, faster, farther, and carry greater loads. How does the jet fly?

Background

The jet age is here. Today you can step aboard a jetliner with engines powerful enough to carry you smoothly and rapidly to the storm-free stratosphere five miles up. You'll travel more than 600 miles each hour--a half mile for every breath you draw.

The powerful jet engines are lighter, more efficient, less complicated, and faster than piston engines.

For the future, jet progress can mean even faster and more comfortable transportation. Advanced jet helicopters and supersonic jets of the Free World will deter agression and help keep you safe.

Concepts

1. The jet principle comes from Newton's Third Law of Motion.
   a. What is Newton's Third Law of Motion?
   b. How is this law related to the way in which a jet flies?
2. Since compressing and heating of air gives the jet engine its power, a jet plane is limited to flight in the earth's atmosphere.
   a. Why is a jet plane limited to travel in the earth's atmosphere?
   b. What are the important parts of a jet engine?
   c. What is the purpose of a turbine in a turbo-jet? In a prop-jet?
3. Penetrating the sound barrier necessitated changing the shape and placement of wings.
   a. What is the sound barrier?
   b. What changes in airplane design made it possible for man to penetrate the sound barrier?
4. Man's ever-increasing desire to fly faster means that our jet aircraft are constantly undergoing change in size, shape, engines, and fuel.
   a. What will tomorrows jet airplanes look like? Be able to do?
   b. What is a supersonic jet? Why are they needed?

Suggested Group Activities

1. Through experimentation, prove Newton's Third Law of Motion.
   a. Releasing an air-filled balloon
   b. Throwing balls while on skates
   c. Action of a water hose
   d. Kick of a gun
2. Through experimentation, observe how jet propulsion works.
   Wrap some baking soda in a napkin and insert it in a bottle that can be corked. Add some vinegar to the bottle; cork, and shake the bottle. Quickly lay it on its side on a row of round pencils. (Do not cork too tightly or bottle could break.) Observe jet propulsion when cork pops out.
3. Identify and describe the parts of a jet engine and their function.
4. Children who enjoy building models might enjoy building small models of the turbo-jet and turbo-prop engines. (Discovering Aerospace pp. 39-41)
5. Observe the shape of waves. Drop a pebble in a large pan of water. Draw a pointed pencil swiftly through water. Note the cone shapes which appear as the waves are compressed. Air behaves in a similar way. A child's Slinky toy is another way to illustrate the way in which sound waves travel.

Vocabulary

combustion	compressor	exhaust nozzle
jetliner	jet stream	Mach number
propulsion	pulse-jet	ram-jet
reaction	sonic boom	sound barrier
supersonic	turbine	turbo-jet
turbo-prop	turbulence	vapor trails

Source Materials and Media

Teacher Books:

Hyde, Margaret O., Flight Today and Tomorrow, N.Y.: Grosset and Dunlap, 1961
Institute of Aviation, Fundamentals of Aviation and Space Technology, Urban, Ill.: Univ. of Ill., 1966
Pacilio, James V., Discovering Aerospace, Chicago: Children's Press, 1965

Student Books:

Colby, C.B., Our Space Age Jets, N.Y.: Coward McConn, 1959
Cooke, David C., Flights That Made History, N.Y.: G.P. Putnam's Sons, 1961
Coombs, Charles, Aerospace Pilot, N.Y.: William Morrow, and Co.
May, Julian, Modern Airplanes, Cleveland: Pennington Press, 1959
Pacilio, James V., Discovering Aerospace, Chicago: Children's Press, 1965

Films:

Airport in the Jet Age, color, 1 reel, Encyclopaedia Britannica Film
An Airplane Trip by Jet, color, 1 reel, Encyclopaedia Britannica Films
Beyond the Speed of Sound, Shell Oil Company

6. Collect clippings about current jet aircraft developments and record flights for a News Booklet.
7. Make a frieze of "Now and Then" of jet air transportation.

Suggested Individual Activities

1. Through reports, such questions as these might be explored:
   a. What is meant by Mach 1?
   b. What effect does temperature have on speed of sound?
   c. What is the sound barrier?
   d. Why do jets fly in the jet stream?
   e. When was the first jet plane flight made?
   f. What advantages does a turbo-prop engine have over a turbo-jet engine?
2. Develop a "Who's Who" on jet planes.
3. Select a current jet pilot and do a biography of his flight career.

Teacher Notes:

Student Evaluation

1. Are the pupils familiar with Newton's Laws of Motion and their application in jet aircraft?
2. Do the pupils realize that, even though we have progressed tremendously in jet aircraft design, jets will change even more in the future?
3. Have the children learned to observe their experiments and to reason *why* certain things happen?

FLIGHT THROUGH AIR AND SPACE

Statement of the Problem

With the development of the rocket, man has the ability to move into space. How do the rockets and space ships fly?

Background

The history of rockets dates back to 1232 A.D. when the Chinese used them against the Mongols. There are smatterings of reports of rockets being used at different times through the succeeding years. Study of rockets was accelerated in the late 19th century. The science of rocketry has developed rapidly during the last 30 years.

We are in the age of rockets and space. Research rockets have been successfully fired and much valuable information has thereby been acquired. Making the child aware of what we are doing now in our space age is the challenge of the teacher.

Concepts

1. Rockets can travel in airless space because they carry their own oxygen source and do not need air for lift.
   a. What is oxygen? How is it carried in the rocket and how is it used?
   b. Who was Robert Goddard? What discoveries are generally credited to him?
   c. Why are rocket engines often confused with jet engines? How do they differ?
   d. How does the principle of action and reaction apply to rockets?
   e. How can a rocket fly without wings?
   f. What is the force of burning gases called?
2. The rocket's propulsion system must exert enough thrust to escape the earth's gravity.
   a. What is meant by escape velocity?
   b. How does the principle of the gyroscope effect the steering of the rocket?
   c. What are the different kinds of rocket fuels?
   d. Why do rockets have multistages?
   e. Explain why the various stages of rockets need a different kind of fuel?

Suggested Group Activities

1. Illustrate how a gyroscope works by spinning a toy gyroscope and observe that its rapidly turning wheel resists any effort to tip over.
2. Wind up three toys such as a truck, a car, and a motorcycle. Place them at the same starting line. Measure how far each one traveled. Wind them up once again. Place the motorcycle atop the car and the car atop the truck. Allow the truck to go as far as it will, then release the car, when the car stops, release the motorcycle. Observe the greater distance. Compare performance to multi-stage rocket.
3. Discuss and relate the different states of matter as they pertain to the fuel of a rocket. Suggested examples: solid fuel (fire cracker), gas fuel (carbon dioxide capsule), liquid fuel (charcoal lighter fuel or alcohol)
4. Through experimentation determine how an astronaut comes out of orbit. (See Discovering Aerospace pp. 140-141)
5. Through experimentation show that the combustion in a rocket engine requires oxygen. (See Discovering Aerospace pp. 140-141)
6. Through experimentation show how a rocket turns. (See Discovering Aerospace pp. 110-111)

3. A rocket that carries a warhead is called a missile and a rocket that carries a satellite, a capsule, or a probe is called a launch vehicle.
   a. What is a missile?
   b. How does our modern army and navy use rockets?
   c. How does a spaceship reach orbit? Stay in orbit? Return from orbit?

Vocabulary

apogee	astronaut	astronautics
ballistics	booster rocket	burn out
inertia	launch vehicle	missile
multi-stage	NASA	nosecone
capsule	orbital speed	cosmonaut
countdown	docking	elliptical orbit
gantry	gyroscope	escape velocity
perigee	probe	guidance system
propellant	reentry	orbital speed
rendezvous	spacecraft	recovery fleet
tracking		

Source Materials and Media

Teacher Books:

Institute of Aviation, Fundamentals of Aviation and Space Technology, Urbana, Ill.: Univ. of Ill. 1966
Pacilio, James V., Discovering Aerospace, Chicago: Children's Press, 1965

Student Books:

Bendick, Jeanne, The First Book of Space Travel, N.Y.: Franklin Watts, 1963
Bergaust, Eric, Rocket Power, N.Y.: G.P. Putnam's Sons
Burt, Olive, Space Monkey, N.Y.: John Day Co., 1960
Chester, Michael, Let's Go On A Space Trip, N.Y.: G.P. Putnam's Sons, 1963

7. Demonstrate elliptical orbit, orbital velocity, apogee and perigee with a spool on the end of a thread. (Discovering Aerospace pp. 118-119)
8. Build a vocabulary of terms used in rocketry.
9. Collect newspaper articles. Build a bulletin board display about current happenings in air and space. Use news maps with clippings attached where the event occurred.
10. Watch television programs pertaining to space and space travel. Make a map showing tracking stations.

Suggested Individual Activities

1. Make an album of U.S. launch vehicles.
2. Make individual reports on the various satellites.
3. Have children consider these problems:
   a. What is meant by a guidance system in rocketry?
   b. Why does the airframe of a rocket need to be sturdier than our present day airplanes?
   c. Why do we need a complete built-in, earth-like environment for the crew?
   d. In what ways will the newly designed aircraft (X-15) affect our lives?
   e. What feat must pilots of the X-15 accomplish before they can be awarded astronaut wings?

Teacher Notes

Coombs, Charles, Lift Off, N.Y.:
William Norrow and Co., 1963
Crosby, Alexander & Larrick, Nancy, Rockets Into Space, N.Y.: Random House, 1959
Knight, Clayton, How and Why Book of Rockets and Missiles, N.Y.: Grosset-Duniap, 1960
Ley, Willy, Space Pilots, Wayne, N.J.:
Golden Press, 1957
Priestly, Lee, Rocket Mouse, N.Y.:
Abelard-Schuman, 1961
Verral, Charles, Go! The Story of Outer Space, Englewood Cliffs, N.J.: Prentice Hall, 1963
Webster Beginning Science Series, Lets Read About Space Travel, St. Louis:
Webster Div.--McGraw-Hill Book Co., 1962
Webster Beginning Science Series, We Read About Rockets, St. Louis: Webster Division--
McGraw-Hill Book Co., 1962

Films:

Rockets: How They Work, color, 1 1/2 reels,
Encyclopaedia Britannica Films
Man in Space, color, 3 reels,
Encyclopaedia Britannica Films
What Makes a Rocket Go, (teacher), 3 reels, NASA
The Space Age: Dr. Goddard to Project Gemini,
b/w, 2 reels, Shell Oil Co.

Filmstrips:

Man in Space, Encyclopaedia Britannica Films,
(Walt Disney's) Space & the Atom
Flight Into Space, Encyclopaedia Britannica Films,
(Walt Disney's) Space & the Atom
Space Rockets, Jam Handy Organization,
(Space and Space Travel Series)

Record:

Space Songs, Nasco Science Materials

Student Evaluation

1. Does the pupil have an idea of the history of the rocket and the purpose it will serve for the future?
2. Does he understand that because of the lack of atmosphere in space, the rocket at present is the only feasible vehicle?
3. Are they collecting and reading data pertinent to space, spacecraft, and men involved in them?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAB.* Do not sign your name.

1. Did you cover all material in this unit? YES_____ NO_____

   If NO which problems were covered? _____

2. Is this material suitable for the grade? YES_____ NO_____

3. Was the area too broad? YES_____ NO_____

4. Did you have difficulty obtaining materials? YES_____ NO_____

5. Are the concepts valuable? YES_____ NO_____

6. List Group Activities that you think are:

   Good _____

   Poor _____

7. List Individual Activities that you think are:

   Good _____

   Poor _____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format? _____

   _____

* IMPORTANT: YOUR CHILD LOVES

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd St.

6

TEACHER'S GUIDE

AEROSPACE SCIENCE

SIXTH GRADE

Developed as a part of
The Lincoln Public Schools
Aerospace Curriculum Development Project
Summer, 1966

AEROSPACE

Yesterday's dream - Today's frontier - Tomorrow's life

The following unit of instruction is but one attempt to focus the eyes of elementary school students on the future -- their future! It is our hope that through the study of this material, these children will be better prepared to live this future, and that they, in turn, will project beyond this limited view to an even more attractive life for their children.

Today, more people are involved in the aerospace industries than are in any other industry. From the student learning to fly to the first astronaut on the moon and beyond, their achievements affect the economic and cultural growth of our great country. It becomes increasingly important each year that our children are true citizens of the Aerospace Age.

Albert R. Hibbs, a physicist deeply involved in today's space science, has stated, "It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn. . ." This premise helped guide the persons who put this material in unit form. Facts, concepts, experiments and conclusions are important, but it is also important that the student become involved in a study where his interest drives him to explore and draw his own conclusions. If he acquires the processes needed to investigate and gains the desire to do an investigation, then our science material has done a two-fold job.

If each teacher who approaches the introduction of her aerospace unit will give careful thought to the following statements, we believe that she will have an enjoyable and profitable period of time in air and space with the children in her classroom.

1. A teacher can best judge how extensively each group or individual will become involved in the material presented.
2. Groups or individuals will be encouraged to develop "in depth" those areas which lend themselves to their interests.
3. Each unit will be opened with the most current happening in air or space and the teacher will use this interest point to guide the children into the development of the unit.
4. It is not expected that a teacher develop all suggested material of a unit, nor should the unit limit additional development if a teacher finds a special field of interest.
5. In the presentation of the concepts, which are stated under each problem of a unit, it is as important to develop the processes of investigation and reaching conclusions as it is to learn the concepts.

- Aerospace Science Committee, Summer, 1966 -
Bernard Nutt, Chairman

Beverly A. Allen
Phyllis Aman
Gerald Anderson
Joeline F. Beck
Eleanor Buller
Phyllis Conway
Luella Craig
Fred Esser
Mary R. Evans
Dennis C. Hansen
Katharine Hoover
Winona Malolepszy
Vern Martin
Laura Staats
Dolores Painter
Madelyn Palmer
Helen Robbins
Maxine Shasteen
Theresa Stetz
James Winney

LEARNING TO LIVE IN SPACE

A Sixth Grade Aerospace Unit

OVERVIEW

Man's quest for knowledge has now carried him beyond the comfortable confines of the earth's atmosphere into the vast reaches of his universe. But can he adapt to life there, especially for long periods of time? Whether or not he can survive depends upon his ability to adapt himself to the perils and risks of the unknown. He must not only surmount the problems of gravity and control of his movements in space but also he must cope with physiological and psychological requirements.

There are many problems related to living and working beyond the earth's atmosphere. These questions have been probed by categorizing them as follows: Natural Problems of Space, Man's Inherent Problems, and Extra-terrestrial Life in Space.

An attempt has been made in this unit to allow for individual differences through individual activities and various student resources. Filmstrips and single-concept films are available for individual work. It is up to the teacher's discretion to include, amend, or omit any of these activities or problem areas.

An important consideration in this aerospace unit is that the teacher use the most current information available throughout the year, especially that which is foremost in the news at the time the unit is taught. It might be planned to begin the unit at the time of an outer space probe, or at some other time when outer space will be in the news of the world.

Hansen, Dennis C. - Hillside Elementary School, Westside Community Schools, Omaha, Nebr.

Hoover, Katharine - Longfellow Elementary School, Hastings, Nebr.

Martin, Vern - Rousseau Elementary School, Lincoln, Nebr.

Robbins, Helen - Brownell Elementary School, Lincoln, Nebr.

Winney, James C. - University of Nebraska

LEARNING TO LIVE IN SPACE

Statement of the Problem

The nature of space presents many problems that must be overcome by man if he is to function well in that environment.

Background

The dangers of space travel must be thoroughly studied before man can explore or live in space. Weightlessness is endurable for man; however, the use of artificial gravity is desirable if a crew must spend a long time in a spacecraft. Space vehicles must be pressurized to supply oxygen in necessary amounts. Carbon dioxide must also be constantly removed. It is known that X-rays and other radiations are very harmful to the body, and research is now being conducted to provide protection for man through the use of his suit and space capsule. Man also needs suits and crafts that will protect him from extremely varying temperatures. On the other hand, the danger of collision with micrometeorites is not as great as scientists once feared. Safeguards will eventually be developed against all the known hazards of space travel, and then the limits of space will be extended.

Concepts

1. Radiation may affect man's travel in space.
   a. Why is a careful study of the sun important to space travel?
   b. Which types of radiation could be harmful to man? How? Which could be beneficial? How?
   c. What methods could be used to protect man against radiation in space?
2. Man must re-orient himself and his environment to the problems of weightlessness.
   a. What is the "g" factor?
   b. How has the acquired knowledge of "g" forces helped in coping with the problems of weightlessness?
   c. How will man be able to use weightlessness to his advantage in space?

Suggested Group Activities

1. A model cloud chamber can be made by following these steps: Place carefully fitted circles of black felt against the bottom and top of a small, screw-cap jar (about 4 X 4 inches). Fully saturate the circles with 90% methyl or ethyl alcohol, close the jar, and place it top down on a five-pound piece of dry ice, about two inches thick, wrapped in newspaper with a hole cut in the top wrapping to accommodate the jar. Allow the jar to stand approximately 15 minutes. Then, cover the lens of a slide projector with an aluminum foil cap in which a small hole has been pierced and adjust a fine beam of light at a sloping angle into the jar. Look through the beam at the dark background and notice the cloud tracks appearing, one at a time, at uneven intervals.

d. What adaptations must be made of man's normal environment to exist and work in a weightless state, as in space stations?

3. Artificial means of supplying and regulating pressures must be provided in space.
   a. What results from inadequate pressurization when atmosphere is light or not present?
   b. What provisions have been made for maintaining necessary pressures in space?
4. The composition of air must be rigidly maintained in all of man's space endeavors.
   a. What is the result of prolonged breathing of oxygen?
   b. What provisions must be made for the disposition of gases?
   c. What are some proposed plans for the creation of oxygen in space?
5. Objects such as micrometeorites may not be the danger in space that scientists have always thought they would be.
   a. What have Pegasus and other experimental devices shown us concerning objects in space?
6. An object in space experiences constant changes in temperature.
   a. What effect does the variance of temperatures in space have on man and his experiences in space?
   b. What effect does water vapor have on man's tolerance of heat in space?

Vocabulary

"g" force	oxygen-carbon dioxide cycle
cosmic rays	recycling
micrometeor	space medicine
roentgen	artificial gravity
weightlessness	centrifugal force
irradiation	

2. For an activity on radiation see Navarra and Zafforoni, Today's Basic Science 6, p. 307 Teachers Edition.
3. File flat a two-inch section of the bottom wire of a metal coat hanger. Place a heavy coin at the center; hang the coat hanger by its hook on your fingertip, and swing it around. Notice how the coin stays in place when the coat hanger is swung around.
4. Swing a water pail with a small amount of water in it to show centrifugal force.
5. Slit a section of a mailing tube down one side, and place it around the spoke of a bicycle wheel. Rotate the wheel, and notice that the force resulting from the spinning of the wheel is greater than the pull of natural gravity so that the tube stays out next to the rim of the wheel.
6. Place a drop of olive oil on water two inches deep in a clear glass jar. Slowly add some rubbing alcohol. The oil will sink until it floats beneath the surface in a state of weightlessness. Notice the shape that it assumes. Break the oil drop by striking it with a spoon and observe the shape of globules. This will illustrate weightless liquids.
7. For an activity concerned with pressure see Science, Laidlow, Smith, Blecha, Sternig, 1966, p. 102.
8. Make a demonstration showing that air contains about 20% oxygen. Place lighted candle in a pan of water, and invert a jar over it. The water should rise about 1/5 of the way showing 20% oxygen.
9. How does breathing oxygen affect animals? If possible, place a mouse in 100% pure oxygen. Observe what happens to him.
10. For an activity on varying temperatures see Science is Adventuring, Scott Foresman, 1965, p. 225, Activity 14.

Source Materials and Media

Teacher Books:

Allen, William, Educational Dictionary of Technical Terms of Aerospace Use, Washington, D.C.: NASA Sp-7, U.S. Government Printing Office

Brayn, Leslie, et al., Fundamentals of Aviation and Space Technology, Urbana, Illinois, University of Illinois, 1966

Gardner, Marjorie, Chemistry in the Space Age, N.Y.: Holt, Rinehart, and Winston, 1965

Introducing Children to Space, The Lincoln Plan, Washington, D.C.: U.S. Gov't Printing Office

NASA Educational Briefs, Houston, Texas: Manned Spacecraft Center

Sutton, Richard M., The Physics of Space, N.Y.: Holt, Rinehart and Winston, Inc., 1965

Trinklin and Huffer, Modern Space Science, N.Y.: Holt, Rinehart, Winston, 1961

Viorst, Judith, Projects: Space, N.Y.: Washington Square Press, Inc., 1962

Student Books:

Dewey, Anne Perkins, Robert Goddard, Boston: Little, Brown, and Co., 1962

Greene, Joseph, The Forgotten Star, N.Y.: Golden Press, 1959

Lent, Henry B., Man Alive in Outer Space, N.Y.: Macmillan Co., 1963

Wells, Robert, Alive in Space, Boston: Little Brown and Co., 1961

Wyler and Brand, Science Teasers, N.Y.: Harper & Row, 1966

Suggested Individual Activities

1. For an activity on radiation see Science 6, Mallinson, Mallinson & Smallwood, T. Ed., p. 209.
2. Burn a hole in a paper with a magnifying glass to show power of the sun's radiation.
3. For activities on weightlessness see Science Teasers, Baird and Robinson, Index.
4. Tie a string loosely across the top of a U-shaped arrangement of wood. On a supporting string tie a small toy soldier or other object. Lift the entire apparatus, and when it is hanging quietly, release the string. While he is falling, the soldier can be seen to remain in the same position inside the frame. Since he is not supported by either the string or the frame, he is in a weightless condition with regard to his surroundings.
5. Make reports on Pegasus and other micrometeoroid satellites.
6. Put thermometers in the sun and try out various kinds of materials as insulations such as cotton, copper, paper, and tin. Let students improvise their own ideas here.
7. Put thermometers in sun and shade and take readings. Compare and graph.

Teacher Notes

Films:

All About Weightlessness, Walt Disney Productions
The ABC of G #MN-3446, Washington 25, D.C.:
Potomac River Naval Command, U.S. Naval
Weapons Plant (Bldg. 200)
The NASA Biosatellite Program #160, NASA
Tommy Looks at Space #603, Sterling Movies

Filmstrips:

Atom: Man's Servant (Set), Encyclopaedia
Britannica Films
Conditions in Space, Jam Handy Organization
Hazards in Space Travel #1 31-G, Eye Gate House, Inc.
Man Faces Outer Space, 1355 Inverness Drive,
Pasadena 3, Calif.: Basic Skill Films
Man in Space #484-3, Society for Visual Ed.
Man in Space #8865, Encyclopaedia Britannica Films
Space and Space Travel, Jam Handy Organization
Space Flight Part I and Part II, McGraw-Hill
Text Films

8 mm Concept Films:

Experimental Weightlessness, Film Associates
Free Fall in Space, Film Associates

Records:

Flight of the Bumblebee
The Planets, Holst, Capital, P8-389
Sound Spectacular, Edgar Varise, Columbia

Student Evaluation

1. Do you feel the students have gained an understanding of:
   a. the effects, protection and uses of radiation in man's space endeavors?
   b. the properties of weightlessness and its adaptations to man's needs in space?
   c. the importance of maintaining a constant pressure for man through all his activities?
   d. the necessity of providing an adequate mixture and disposition of gases?
   e. the role of temperature and temperature control in space environment?
2. Has each student become more aware of the problems that face man in space ventures and the proposals for overcoming these problems?
3. Has each student gained a greater appreciation of man's attempt to probe the great unknowns of space that he may more perfectly insure a peaceful relationship among his fellow men?

LEARNING TO LIVE IN SPACE

Statement of the Problem

Many of the problems of space travel occur because of man's inherent needs.

Background

Man is a complex mechanism that requires food, water, and oxygen in order to survive. His body requires the excretion of waste materials. He is subject to psychological problems when confined in small areas for long periods of time. He is a machine that requires exercise in order to keep himself in top working condition. Learning to maintain himself in circumstances foreign to his normal environment is necessary to space travel, exploration and colonization.

Concepts

1. Some provision must be made to handle emergency or temporary medical and dental needs on spacecraft.
   a. How much training would be necessary for the astronauts to handle their own emergency medical and dental needs?
   b. What medical supplies would need to be aboard?
   c. Can man use ordinary remedies like aspirin in space? What effect does the weightless state have on man's use of medicines?

2. Man must devise ways of supplying food and water for long periods of time in a limited space.
   a. Why is it difficult for man to use the same forms of food in space that he eats on earth?
   b. How much food and water would be required for a journey of two weeks? two months? one year?

Suggested Group Activities

1. Study the necessity for knowledge of medicine as man travels in space. Secure bulletins from medical and dental colleges to determine what courses one would need to take to become a doctor or dentist. Study the way in which non-doctors and non-dentists could take care of emergency or temporary medical or dental needs on board a spacecraft.
2. Discuss the various ways of preserving food. Collect items that could be found in the home demonstrating various ways of preserving food. Which of the various processes will be most advantageous to space flight? Include an examination of the processes of refrigeration, drying, freeze-drying, freezing and canning.
3. Prepare a menu for three astronauts who will be in space for one week. Take into consideration the problems of weight and the space that will be used for storage. The menu should be varied and nourishing.

c. What are some ways that this food and water might be supplied?
d. How might forms of algae be used to supply food?
e. What are the advantages of freeze-drying food?

3. Man must learn to take care of his sanitary needs such as defecation, urination, and the control of odors in the small spacecraft.
   a. Why are odors a serious problem in space?
   b. What provision is made for the waste functions of the body such as defecation and urination?

4. Many psychological problems face man as he explores space.
   a. How does isolation from other human beings in a small space affect man's emotional well-being?
   b. Does man become more tired as he works in a weightless condition? Of what importance is fatigue as a factor in hindering or benefiting work in space?
   c. How are astronauts trained to overcome these psychological problems?

5. The clothing that man wears in space is important to his well-being.
   a. What are the best materials to use for space clothing.
   b. What are the purposes that clothing must serve in space besides the obvious one of covering the body?

Vocabulary

claustrophobia	freeze-drying	hydroponic
fatigue	fuel cell	isolation
		psychology

4. Demonstrate the importance of refrigeration to the preservation of food by placing milk in two containers. Place one in a refrigerator and the other in the open room. Compare what happens.
5. Make a terrarium to show a system in which a balance of nature is maintained. See Navarra and Zafforoni, Science Today for the Elementary-School Teacher, Row, Peterson and Company, Evanston, Ill., 1960, pp.418-419.
6. A promising source of power for space vehicles is the fuel cell. For an experiment on the fuel cell and its power and water capabilities see Chemistry in the Space Age, Holt, Rinehart, Winston, 1965, pp. 119-125.
7. Report on the methods of waste disposal in the space program today.
8. Study various kinds of water purification systems. Make models of some of these systems. How might one of these be used in space?
9. Report on the causes of human odors. Why is the control of these odors essential in spacecraft?
10. Make a study of how valuable exercise is to the human system. What happens to living things without exercise? What are isometric exercises? Have the children do some isometric exercises. Why are these exercises good for astronauts to do?
11. Report on how men are selected for the astronaut program. Try placing yourself in a closet and see what your reactions to the limited environment are. Try placing yourself in one position and discover what the difficulties are. Why is it important for astronauts to be personally compatible?
12. Make a study of clothing and clothing materials to find out what the best materials and designs are for controlling temperature, disposing of wastes, and controlling odors. Include mylar.
13. Life depends on the inter-relation between organisms and their environment. To show this, place an aquarium snail in a test tube three-quarters full of water and seal the tube with a stopper. In another similar test tube, place a piece of aquarium plant. In a third,

Source Materials and Media

Teacher Books:

Allen, William, Educational Dictionary of Technical Terms of Aerospace Use, Washington D.C.: NASA SP-7, U.S. Gov't Printing Office

Bioastronautics Data Book, Houston, Texas: Manned Space Center, NASA Sp3006

Federal Aviation Agency, Physiological Training, Oklahoma City, Oklahoma

Gardner, Marjorie H., Chemistry in the Space Age, N.Y.: Holt, Rinehart and Winston, 1965

NASA Educational Briefs, Houston, Texas: Manned Space Center

Navarra and Zafforoni, Science Today for the Elementary School Teacher, Evanston Ill.: Row, Peterson and Co., 1960

Trinklin and Huffer, Modern Space Science, N.Y.: Holt, Rinehart and Winston, 1961

Viorst, Judith, Projects: Space, N.Y.: Washington Square Press, Inc., 1962

Student Books:

Blough, Glenn O., et al., Science Is Adventuring, Chicago, Scott Foresman, and Co., 1965

Crosby, Alexander and Larrick, Nancy, Rockets Into Space, N.Y.: Random House, 1959

Dewey, Anne Perkins, Robert Goddard, Boston: Little, Brown and Co., 1962

Kavaler, Lucy, The Wonders of Algae, N.Y.: John Day Co., 1961

Lent, Henry B., Man Alive in Outer Space, N.Y.: MacMillan Company, 1963

Wells, Robert, Alive in Space, Boston: Little, Brown, and Company, 1961

Suggested Group Activities, cont.

place a snail and a piece of plant. Notice in which environment life can continue for the longest period.

Suggested Individual Activities

1. Some students may wish to devise an experiment to study the effects of lack of exercise on an animal. If we are studying lack of exercise, what controls must we use to insure purity of results?
2. Make a study of the basic instruments and medicines (medical and dental) that astronauts would need to take along on an extended space flight. Secure some of these instruments if possible.
3. Study several kinds of algae to determine rates of reproduction and effectiveness as food.
4. Study a controlled environment in which snails and algae are used to provide the necessary amounts of oxygen and carbon dioxide for life. Other animals such as mice might be used. You would have to devise a way of feeding the mice without opening the container. Compare the weights of the mice and the plants after a few days.
5. For an experiment on purifying water by filtering, see Science is Adventuring, Scott Foresman, 1965, p. 255.

Teacher Notes

Films:

Balance of Life and the Space Age, 12½ min.,
Film Associates of California, 11014 Santa Monica,
Los Angeles, Calif.
Decontamination of Space Vehicles #HQ 35, 17 min.,
color, NASA
Exobiological Safety HQ a65, 12½ min., color
NASA Biosatellite Program #160 C, 28 min., NASA
Tommy Looks at Space #603, 20 min., color,
Sterling Movies

Filmstrips:

Dawning Space Age, 55 frames with 33 1/3 record,
color, Civil Air Patrol, Maxwell AFB, Alabama
Man in Space #8865, 45 frames, color,
Encyclopaedia Britannica Films
Hazards in Space Travel #131-G, 36 frames,color,
Eye Gate House, Inc.,
Man's Preparation for Space Travel, 40 frames,
color, Jam Handy Org.
Medical Aspects of Space Flight, 24 frames, color,
Communicative Arts
Space and Space Travel, The Jam Handy Org.

Other Materials:

Wall Chart, Lunar Garden, Communicative Arts,
P.O. Box 11017, San Diego, Calif., 92111

Teacher Notes, cont.

Student Evaluation

1. Do the students understand:
   a. that some provision to handle emergency or temporary medical and dental needs must be made for prolonged trips into space?
   b. some of the problems of providing food?
   c. the importance of forms of algae in present-day thinking about living in space?
   d. some of the processes of preserving food?
   e. the importance of controlling odors in spacecraft and making provision for defecation and urination?
   f. some of the problems of human isolation?
   g. the problem of fatigue as a factor in the exploration of space?
   h. clothing materials and their uses?
   i. space-suit design and the purposes of the space-suit?
   j. the importance of exercise to the human organism?

LEARNING TO LIVE IN SPACE

Statement of the Problem

Man is studying the possibility of extraterrestrial life.

Background

Man's body is adapted to the conditions found on earth. If the conditions changed, even a little, life would become difficult or impossible.

In space, man's body must be supplied with almost the same environment as on earth.

Conditions on other planets probably prevent life, as we know it. However, most scientists agree that the appropriate conditions need not necessarily resemble those on earth nor must all life be comparable to earth forms.

Much is being learned about our planet and other heavenly bodies from satellites, probes, and man's journeys into space. But man must explore further to gain more knowledge. Plans have been made for a space station which will be used by astronomers, chemists, and doctors for a study of our earth and weather; it may also be used as a refueling and take-off point for spaceships.

In order to survive and to fulfill the missions assigned to him in space, man must learn to live there with a reasonable degree of comfort, efficiency, and freedom of movement.

Concepts

1. Factors that determine life as we know it are atmosphere, gravity, temperature, and geology.
   a. What is life?
   b. What are the conditions necessary for life?
   c. How does our atmosphere protect life on earth?
   d. What is gravity?
   e. What effect does gravity have on our atmosphere?
   f. How does gravity affect you?
   g. How are we learning more about our earth and atmosphere?
2. Much knowledge is being learned about our earth and other heavenly bodies from satellites, probes, and man's journeys into space.
   a. How have satellites helped in the study of weather?

Suggested Group Activities

1. Experiment to find out how plants are affected by light, temperature, water.
2. Experiment: Take 3 candles of same size to represent 3 planets. Place candles at different distances from a large light bulb representing the sun. Switch on the light and after five minutes squeeze each of the candles to feel the firmness of the wax. How was each candle affected by the heat from the bulb?
3. Experiment: Use lettuce leaves in place of candles. Change time to 15 or 20 minutes.
4. Make a mobile of the solar system.
5. Make a model of a space station, a moon city, or city on another planet.
6. Grow some seeds by hydroponic farming. (See Young People's Science Encyclopedia)
7. Plan and write a play of "Life in a Moon City", or Life on Another Planet."

Concepts, cont.

b. What information have the satellites relayed to us about the earth's shape?
c. How are the satellites helping map makers?
d. What have we found out about the moon from our satellites?

3. The possibility of life on other planets is being studied.
   a. Is there life anywhere else in the universe?
   b. How have we learned about other planets?
   c. What have our satellite probes told us about Venus and Mars?
   d. How do distances from stars affect the chances that life exists on the planets?
4. Man must develop space stations, space ferries, and space ships in order to further his exploration of the universe.
   a. What is the purpose of a space station?
   b. How will a space station be designed and constructed?
   c. What equipment must a space station contain?
   d. How will people and supplies get up to the space station?
   e. What provisions will be made for maintaining man's environment inside a space station?

Vocabulary

acceleration
astronautics
atmosphere
axis
centrifuge
docking
extraterrestrial
geology
gravity
orbit
payload
probe
revolution
rotation
satellite

Suggested Group Activities, cont.

8. Plan a vacation to the moon or to another planet. (Maps may be drawn, times and distances figured, tickets made, etc.)
9. Keep a scrapbook of current news about space throughout the year.
10. Trip to a planetarium.

Suggested Individual Activities

1. Make charts of layers of the atmosphere, man's flights into space, altitude scales, the planets and their orbits, time and distance tables, rotation and revolution charts of the planets, gravity chart of the planets.
2. Reports and drawings of satellites: Explorer, Anna, Pioneer, Surveyor, Nimbus, Tiros, Mariner, Ranger.
3. Reports on Galileo, telescopes, Dr. Wernher von Braun, Sir Isaac Newton.
4. Make a model of a satellite.
5. Investigate known conditions on other planets and draw conclusions about life on them.
6. Draw a picture of life on another planet.
7. Make a diorama of life on another planet.
8. Place a thermometer at different distances from a large light bulb. Observe the differences in temperature.
9. Compute your weight on the moon.
10. Make drawings of a station in space with ferries and docking platforms.

Source Materials and Media

Teacher Books:

Clark, Arthur C., The Challenge of the Spaceship, N.Y.: Harper and Row, 1959
Coombs, Charles, Gateway to Space, N.Y.: William Morrow and Co., 1960
Nephew, William and Chester, Michael, Moon Base, N.Y.: Putnam's Sons, 1961
Schneider, Leo, Space in Your Future, N.Y.: Harcourt, Brace and World Inc., 1961

Student Books:

Bendick, Jeanne, The First Book of Space Travel, N.Y.: Franklin Watts, Inc., 1963
Bova, Ben, The Uses of Space, N.Y.: Holt, Rinehart and Winston, Inc., 1965
Bryan, Leslie, et al., Fundamentals of Aviation and Space Technology, Urbana, Ill.: University of Illinois, 1966
Crosby, Alexander and Larrick, Nancy, Rockets Into Space, N.Y.: Random House, 1959
Dietz, David, All About Satellites and Space Ships, N.Y.: Random House, 1962
Egan, Philip S., Space For Everyone, Chicago: Rand McNally, 1961
Highland, Harold J., Planets and Interplanetary Travel, N.Y.: Grosset and Dunlap, 1962
Hutchinson, William and Spielberg, Kurt, Space Travel, N.Y.: Maxton Publishers, 1958
Hyde, Margaret, Off Into Space, N.Y.: Maxton Publishers, 1958
Hyde, Margaret, Flight Today and Tomorrow, N.Y.: McGraw and Hill Book Co., 1962
Jacobson, Cecilia, Lauby, J., Konicek, Richard, Thinking Ahead in Space, N.Y.: Amer. Book Co., 1965

Media, cont.

Ley, Willy, Man-Made Satellites, N.Y.: Guild Press, 1958
Moore, Patrick, The Worlds Around Us, N.Y.: Abelard Schuman, 1956
Nephew, William and Chester, Michael, Beyond Mars, N.Y.: Putnam's Sons, 1960
Pacilio, James V., Discovering Aerospace, Chicago,: Children's Press, 1965
Parker, Morris Bertha, The Sun and Its Family, N.Y.: Harper and Row, 1962
White, W. B. Neighbors in Space, N.Y.: Rand McNally, 1959
Wyer, Rose and Ames, Gerald, New Golden Book of Astronomy, N.Y.: Golden Press, 1965
Young People's Science Encyclopedia, N.Y,: Children's Press, 1962

Films:

Apollo Mission, North American Aviation, Space and Information Systems Division, 12214 Lakewood Blvd., Downey, Calif., 90241

Program #2 "Moon Exploration", Douglas Aircraft Co., Advertising Film Services, Dept. G-83 Location G-20, Santa Monica, Calif.

A Trip to the Moon, Encyclopaedia Britannica Films

Life on Other Planets, NASA

Centrifugal Force, McGraw-Hill

Filmstrips:

The Solar System, Set 2, N.Y.: McGraw-Hill
- Introduction to the Solar System
- Our Sun
- Mercury and Venus
- Mars

Filmstrips, cont.

The Giant Planets: Jupiter, Saturn, Uranus, and Neptune
Between the Planets
The Earth and its Moon, Series Set 1,

McGraw-Hill
The Earth as a Planet
Information from the Satellites

Walt Disney's Space and the Atom, Wilmette, Ill.

Encyclopaedia Britannica Films
How Space Travel Helps Us
Man in Space
Travel in Space
How an Astronaut Lives in Space
Flight into Space

Jam Handy Organization, Detroit, Mich.
Space and Space Travel
Space Stations
What are Space Stations

Transparencies:

Spaceflight, Chicago: Denoyer-Geppert Co.
Solar System, Chicago: Denoyer-Geppert Co.

Teacher Notes

Student Evaluation

1. Do the children understand:
   a. conditions on earth necessary for life?
   b. that the place of a planetary body in the solar system helps to determine the kind of life?
   c. the limits of space travel and space living?
2. Did the children form the conclusion that forms of life on other planetary bodies might differ from life on earth?
3. Do the children realize that man must learn to live in space with the help of specially constructed bases?
4. Do the children realize the importance and work of our man-made satellites?
5. Have the children realized the value of a space station and further space exploration?
6. Do the children realize that to live successfully in space, or on earth, man must understand the laws of the universe and use them for the benefit of all, which includes further exploration?

EVALUATION FOR AEROSPACE SCIENCE ACTIVITIES

When you have completed this section please complete this evaluation sheet and send it to Mrs. Karen Timmons, Lincoln, Nebraska, PSAP * Do not sign your name.

1. Did you cover all material in this unit? YES_____ NO_____

   If NO which problems were covered? _____

2. Is this material suitable for the grade? YES_____ NO_____

3. Was the area too broad? YES_____ NO_____

4. Did you have difficulty obtaining materials? YES_____ NO_____

5. Are the concepts valuable? YES_____ NO_____

6. List Group Activities that you think are:

   Good_____

   Poor_____

7. List Individual Activities that you think are:

   Good_____

   Poor_____

8. What other interesting ideas did you use? Please list.

   _____

   _____

9. How would you alter the format?_____

   _____

* IMPORTANT: YOUR GRADE LEVEL

* Aerospace Curriculum Development Project, Lincoln Public Schools, 720 South 22nd St.